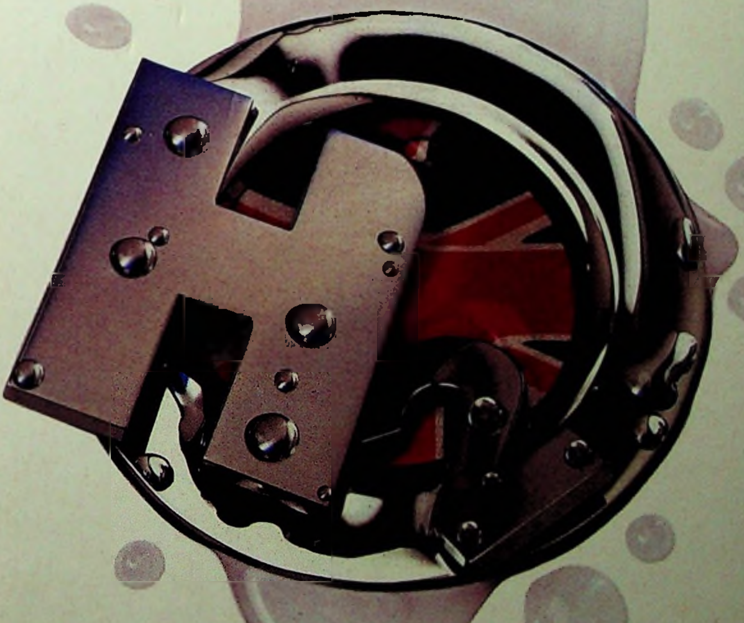
OPTIMA

DOWN THE DRAIN

WATER, POLLUTION AND PRIVATISATION



Stuart Gordon

DOWN THE DRAIN Stuart Gordon

Water, water, everywhere, But is it fit to drink?

DOWN THE DRAIN is a scathing indictment of how we abuse and misuse our most valuable natural resource. This broad and detailed investigation of both official sources and independent studies:

- **shows how acid rain, lead pipes, raw sewage and pesticides contaminate our water supply, destroy flora and fauna and endanger our health.**

- **identifies the natural properties of water, and explores the implications of modern water treatment processes like chlorination.**

- **traces the history of human reliance on water, from ancient water cults, through the Black Death, to the Victorian concern with public sanitation.**

- **questions the viability of the privatisation of the water authorities in England and Wales.**

Equally damning of domestic apathy, industrial negligence, and official cynicism, DOWN THE DRAIN urgently presses for new thinking and action to halt our quickening slide into environmental disaster.

MACDONALD OPTIMA

Category:
CURRENT AFFAIRS/
ENVIRONMENT

Cover design/photography by Jefferson Godwin

UK £5.99

ISBN 0-356-17944-3

00599

Australia $19.95*
New Zealand $21.95* (incl. GST)

- Why did Greenwich householders find live maggots, rust and dirt flowing out of their taps in October 1986?

- Why can Sellafield nuclear power station dump 2.2 million gallons of low-grade nuclear waste into the Irish Sea *every day*, so that it has now become the most radioactive sea in the world?

- How were 20 tonnes of alum accidentally dumpd into mains water at a treatment works on Bodmin Moor, poisoning 20,000 people and killing 60,000 fish in the Camelford area in July 1988?

- Why do ten million people in the United Kingdom still receive water through old lead piping, while the government is conscientiously encouraging the use of lead-free petrol, and research shows that even tiny amounts of dissolved lead can encourage brain damage, miscarriage, impotence and premature death?

OPTIMA

DOWN THE DRAIN

WATER, POLLUTION AND PRIVATISATION

STUART GORDON

ILLUSTRATED BY JENNIE SMITH

First published in 1989 by
Macdonald Optima, a division of
Macdonald & Co. (Publishers) Ltd

A member of Maxwell Pergamon Publishing Corporation plc

British Library Cataloguing in Publication Data

Gordon, Stuart, 1947-
Down the drain.
1. Great Britain. Water supply
I. Title
628.1'0941

ISBN 0-356-17944-3

Photoset in Century Schoolbook
by Leaper & Gard Ltd, Bristol, England

Printed and bound in Great Britain by
The Guernsey Press Co. Ltd, Guernsey, Channel Islands.

Macdonald & Co. (Publishers) Ltd
66-73 Shoe Lane
Holborn
London EC4P 4AB

To Pam, who has had to spend three months listening to pollution horror stories. Also to my mother and father, who have at last had their lead piping replaced, and to everyone everywhere who works so that this planet and the life upon it should have a healthy future.

Acknowledgements

Thanks are due for their help and information to the following:

Richard Easton, for starting the whole thing off;

Grampian Regional Council's Director of Water Services and his staff for showing me round and explaining their treatment facilities at Inchgarth, Mannofield, Persley and Nigg in Aberdeen, and the Glenlatterach Reservoir, Moray. Also to the above and to these water authorities and services for answering requests for information: Central Regional Council, Lothian Regional Council, Anglian Water Authority, Severn-Trent Water Authority, Southern Water Authority. Also to the Water Authorities Association; the Water Research Council; and the Scottish Development Department for doing likewise;

The following organisations and concerned bodies for freely offering information and material: ACOPS (Advisory Committee on Pollution of the Sea); British Trust for Ornithology; Conservation Trust; Council for the Protection of Rural England; Countryside Commission; Friends of the Earth; Friends of the Earth (Scotland); Green Party; National Pure Water Association; National Anti-Fluoridation Campaign; Nature Conservancy Council; Royal Society for Nature Conservation; Royal Society for the Protection of Birds; Scottish Green Party; Scottish Society for the Prevention of Cruelty to Animals.

The publishers would like to thank Jefferson Godwin for the cover design and photography, and Jennie Smith for the illustrations.

CONTENTS

INTRODUCTION: WE'RE ALL WETS

In Britain today we face one crisis potentially more acute than any of the others before us — a crisis caused by our attitude to a substance so basic to life on earth that without it we'd have no other crises to worry about — a substance not only above us, below us, and all around us, but on the move in and out of us all the time. Up to 83 per cent of your body, my body, everyone's body consists of it. In the body of a child the figure may go as high as 90 per cent. In a tomato, 95 per cent. On average we each contain about 38 litres of it and need to replace at least two of these every day. Go running on a hot day and its loss, by evaporation through the skin, can endanger the health. Go without it for as few as 70 hours and death results. It has neither colour, odour, nor smell, yet 71 per cent of the Earth's surface is covered by it. Literally all terrestrial life depends upon it. Water.

Yes, water. Even as we use it we take it for granted. It's a century since adequate, safe public water and sewage services were established in Britain; since cholera and typhus were tamed. Since then? Who considers what's always there, often too much of it. It sweeps our shores, falls from the sky, flows from the hills, wells from the ground. Most important, it gushes from our tap whenever we want. We drink it, bathe in it, sail on it. With it we wash our dishes, clothes, and cars; we grow crops and flush away our waste; we brew beer and make coke, cement, and chemicals. It is so universal that we *see* it only if it rains too hard and rivers flood, or if drought imposes hosepipe restrictions . . . or if a pollution scare makes us worry about it — briefly. After Chernobyl's poison rain, bottled water all but vanished from supermarket shelves in London. Yet after the token week of worry, people forgot (unless they were sheep-farmers in Wales, Cumbria or Galloway) and Perrier was in stock again as we returned to our taps.

But problems don't vanish by being ignored. This particular problem is increasingly hard to ignore. For though in Britain we like to think of our water supplies as reliable and more potable

than water found abroad, it now grows clear that such complacency is stupid. Toxins, wastes, and chemicals used to force-feed the land increasingly invade groundwater, river, and reservoir. Concern mounts about the possible water-borne origin of 'blue baby syndrome' and Alzheimer's disease. Once-plentiful fish and bird-life in and about our northern waters have in many cases vanished completely due to acid rain. Rivers and aquifers in Yorkshire, the Cotswolds and other parts are drying up due to over-abstraction by water authorities to meet public and industrial demand. The North Sea is so polluted by PCBs, heavy metals, oil, sewage and other wastes that bathing in it can literally prove fatal — the Coastal Anti-Pollution League was formed by a man whose young daughter died of polio contracted by bathing in sea-borne sewage.[1] For we British, an island race, still dump untreated sewage at sea! No wonder we're known as 'The Dirty Man of Europe'.

Meanwhile our largely Victorian sewage systems are in such a state that the Department of the Environment admits to an 'unacceptable' nationwide failure rate of 22 per cent, even as some chemicals used in our water treatment plants to clarify or disinfect raw water are themselves called into question and accused of promoting illness.[2] Alum is presently the most controversial of these, especially after the accident in Cornwall of July 1988, when 20 tonnes dumped by error direct into the mains led to the deaths of 60,000 fish and the poisoning of 20,000 people in and about Camelford, with who knows what long-term effects?

Perhaps inevitably the official line remains (in the words of a Water Authorities Association spokesman who was asked about leaked documents expressing official concern over aluminium pollution and its connection with the increasing incidence of senile dementia) that: '. . . our water is perfectly safe'.[3]

Maybe, given current political circumstance, he could say little else. For the background to all this is that by the end of 1989 the government should have completed at least the first part of its scheme to 'float' the English and Welsh water authorities into private hands. It looks as if, by 1990, 83 per cent of every body in England and Wales will be somebody else's stockholding interest. Already, there have been massive share purchases in the Statutory Water Companies by French-owned interests like Generale des Eaux, Lyonnaise des Eaux, and Cementation-SAUR. Will they be turning water into wine, or

into hard cash? Conservation groups such as the Council for the Protection of Rural England fear that after privatisation the new water plc's may be concerned more with profit maximisation than with efficient public supply.[4] They warn that some or all of the 455,765 acres of the land owned by water authorities in England and Wales may be sold off, or that the public will be charged for entry to these areas, many of them uplands of outstanding natural beauty, such as the Elan Valley in Wales, Haweswater and Thirlmere in the Lake District, and other sites in the Peak District, Snowdonia, the Brecon Beacons, and Dartmoor.[5] The Countryside Commission has published an inventory listing 300 such sites of conservation and recreation value, totalling a third of a million acres, all now at risk of potentially damaging business exploitation.[6]

The government's attitude is like Pilate's – swift cleansing of the hands in a bowl of privatised water, followed by a shrug and a look — anxious, maybe? — the other way, towards Brussels. For ever more zealous EEC water safety rules don't suggest lower prices. The promise is of major price hikes, economising cutbacks in staff and equipment, and increases in capital borrowing by water plc's driven to satisfy not only stockholders and the EEC, but also the public's growing demand for environmental health. So water officials admit. Is it surprising that most of them spoke to me 'off the record'? Because when the price hikes come, as they must, no doubt the government will still be washing its hands while we're paying through the tap and wondering who to blame.

But rising costs are only part of a wider crisis of public will and political accountability. Cleaner water will be expensive. At present the average daily cost per head for water and sewage services is in the region of 25p.[7] Yet the industry, whether privatised or not, faces costs in the region of £1 billion a year not only to improve but simply to maintain the existing quality of supply.[8] The slogan 'the polluter pays' is bandied about, but so far there is little evidence of desire on the part of the authorities or the government to enforce the principle.

To put matters in perspective, we need to know more about water — from its chemistry and what's in it naturally, to the history of human reliance upon it; from how we use it, to what we put in it by accident or design, and how we deal with that . . . all in a society committed to an annual 3 per cent growth rate that means a doubling in consumption every 25 years.[9]

This account offers some facts. None are new or unknown. Most are gleaned from sources no more esoteric than the daily press.

Who am I? Why did I want to write this book? Normally I write what's termed 'science fiction'. But with the tide of 'progress' as rapid as it is, many of science fiction's direr social dreams are already coming true. Why fantasise horrors that exist in fact? Some months ago I took a walk along the Moray Firth coast between the villages of Burghead and Findhorn. It was a wild grey day. The waves were shooting in, driven by a strong north-westerly. Clean waves? Not on your life! For over a mile I was wading knee-deep through a filthy froth of vomit-coloured scum driven up onto the beach. Perhaps the prevailing wind had forced it in from the oil-rig construction yards at Nigg on the Cromarty Firth, some thirty miles north-west over the Moray Firth. Maybe it had another cause. Amid this muck I came eye-to-eye (more accurately, eye-to-eye-socket) with a dead seal. I felt ashamed and angry. As a child I played on these same northern beaches by this same sea. Wild horses wouldn't drag me into it now. Even in a northern sea this kind of pollution happens too often.

It's time it stopped. But we won't stop it without realising the immense scale of the problem . . . nor without realising that the problem has its roots in our own accustomed habits and demands.

Hopefully you won't find this easy reading. I didn't find it easy to write. It brought me nightmares — when I was able to sleep, that is.

1 WATER: THE BASICS

The moving waters at their priestlike task,
Of pure ablution round Earth's human shores.

So wrote John Keats in the early years of the nineteenth century, when, though the seas may have been clean, human understanding of water-borne disease and bacteriology remained primitive. Keats himself died young, as did many then, and often enough they died during the terrible epidemics of typhoid that ravaged industrial towns where people shared a common water supply without any sanitary precautions. Or they died of dysentery which, in time of war, often proved more fatal than enemy action. As recently as the US Civil War, twice as many Union soldiers died of disease than were killed in battle or later died of their wounds. The Russo-Japanese War of 1904-05 was the first in recorded history in which the enemy took a greater toll than disease — usually meaning water-borne disease.[1] So, given the foully-dangerous, filthy conditions in which most people lived their daily lives even as recently as a century ago, it's not surprising that Keats should have spoken of the seas and their 'priestlike task' in the way that he did.

I say this at the outset to illustrate the irony of our situation. Due to advances in the science of water and sewage treatment we no longer drop like flies from cholera, typhus, typhoid or dysentery. Instead by our industrial and domestic activities we poison the seas themselves, so that the 'pure ablution' of which the poet spoke has become a bad joke. Indeed, as mentioned earlier, you can now catch your death by bathing in those same 'moving waters'. Lately the UK government designated only 27 beaches *in this entire island* as fit for safe public bathing by EEC standards.[2]

What a turnaround! Have we such short memories? How

have our gains in scientific knowledge led to such loss of respect for the waters? Look back in the poetry and literature of the ages to see how strongly people have always felt about this subject. In crucial ways our understanding of water seems less now than it was in times when, due to insanitary conditions and lack of science, people were lucky if they lived to thirty. For, as Goethe acknowledged two centuries ago:

Everything originated in the water,
Everything is sustained by water.

If this is true (were Goethe and Keats both pre-scientific idiots?) then why do we act as we do? Perhaps we take water so much for granted that we just don't bother to consider what it *is*. So let's start by doing just that. What *is* water? What are its nature, properties, and capacities?

PROPERTIES OF WATER

First and most obvious is that, without water, life on Earth is impossible. That means any life, not just human. Water is literally the stuff of life. It is the simplest, most common of all chemical compounds — yet also one of the strangest. For water starts by breaking most of the chemical rules which other compounds obey, so much so that we still don't know exactly how it works.

For example. Instead of shrinking to a solid state as its temperature falls, at 4°C water starts to expand . . . until at freezing point (0°C, 32°F) it has grown in volume by as much as 10 per cent.[3] That's why rocks split and pipes burst on cold nights. And why life on Earth is possible. Otherwise ice would sink, locking all water solid until no free flow existed anywhere — no ocean, streams, rivers, or rain. Meaning no life.

For example. Water can react with itself as both acid and base, being both gentle enough to sustain all life and so hard that it can corrode the toughest metal. Just about every chemical reaction of which we know takes place in an aqueous solution. Thus the essential minerals pass from soil to root to flower; thus creatures like human beings digest their food; thus life is sustained. Because water is strong, flexible, and astonishingly promiscuous. It gets into everything that lives, and promotes life by its activity, so much so that we scarcely even notice it, save by its effects — or by the lack of them. Have you been thirsty lately?

H_2O. Two hydrogen atoms to one of oxygen. Two potent, basic elements, one the building block of the universe, the second the fiery source of our breath. Locked together in the water molecule, this combination of atoms behaves in a fashion so purposefully active that it's an insult to call it *almost* alive, as we who consider ourselves *fully* alive depend so absolutely on its activity. In a sense, since we were born from it, water can be seen as more intelligent than we are. Our own intricacies, from DNA-helix to blood cells and the major organs that let us walk, talk and act, are no more amazing than those guaranteeing the continued stable existence of the water molecule. For the combination of H_2 and O is inherently unstable. Its bonding is a matter of lacing so intricate that human artistry is put to shame. In ice, every water molecule connects with four others, so creating the most perfectly bonded hydrogen structure known. Even in free water, the discipline of the molecule is as extraordinary as its talent (capillary action) for the hydrogen molecules at the edge to reach out and mate with any free oxygen to be found, thus creating life's circulation.

But one could drown in the subject of water's weirdness as easily as in water itself. It is no more consistent in its behaviour than we are. It is affected in its motions and reactions not only by the moon, but by the sun and by electromagnetic fields, both local and cosmic. 'Water is sensitive to extremely delicate influences and is capable of adapting itself to the most varying circumstances to a degree attained by no other liquid', said Italian chemist Giorgio Piccardi in 1962, following years of experiments on the effect of outside influences, such as sunspots, on the variability of the chemical reactions taking place in water.[4]

Another unique quality of water is its abundance on this planet. In the universe as a whole, it is probably rare. In this sweet world, sometimes we seem to have too much of it (those in Bangladesh would probably agree). There are 8,000,000 cubic kilometres of it rising up through the soil, 12,000 cubic kilometres drifting in the atmosphere as vapour, and 12,000,000,000 cubic kilometres freely available in the oceans.[5] More than enough for a shower. More than enough for a flood. And more than enough, some might argue, for us to continue chucking our waste into the seas forever. But let's take a closer look at what goes on in these seas we treat as open sewers, seas that are mother, midwife, and wet-nurse to all life on this planet.

IN THE OCEANS

The Earth is about 4,600,000,000 years old. The oceans have existed for two-thirds of that time, as have the first life-forms — bacteria and blue–green algae of the sort which today treatment processes screen out of our tap-water. These same algae were responsible for the liberation of oxygen as a free gas in the atmosphere.[6] They and the oceans are not only far older than animal forms with hard skeletons, which appeared a bare 600 million years ago during the early Cambrian era, but older than the continents too. For it's just 200 million years since the original super-continent, Pangaea, began to split apart, less than 50 million years since the continents and seas took on the shape we know today. By then the oceans teemed with life. So did the continents. And all life on land came out of the oceans, out of the water.

Salt water in the oceans covers 71 per cent of the Earth's surface. 97 per cent of the water on Earth is salt water. The average concentration of salt in the oceans is about one part to 30 parts of water. Other substances, though thinly spread, are present in huge quantities. One cubic kilometre of sea water is estimated to contain over 10 kilograms of gold. The oceans would provide more raw materials than the Earth's crust if we knew how to mine them.

Ocean waters are divided into three zones. Descending 200 metres from the surface, the *euphotic* zone admits enough sunlight for plants to grow. This is the realm of plankton, the small fish that feed on them, the sea-birds and larger fish that feed on the small fish, and mammals like blue whale and porpoise. Close to shore live bottom-dwellers like anemones, crabs, starfish, also seaweed and other plants. The middle, *bathyal* zone, where the continental shelves fall away, hosts a great diversity of life, including squid and the sperm whale, which can dive to 1,000 metres. And needs to, with us about. Below lies the dark *abyssal* zone, 5,000 metres deep. Some ocean trenches sink far deeper. Down there the only light is from luminous fish, bacteria and squid, under pressure so great that such creatures burst like small baloons if they are brought rapidly to the surface.[7]

Two-thirds of Earth's surface lies under at least 200 metres of water. Three-quarters of the ocean is colder than 10°C. Temperature drops with depth. Even in tropical seas, water nearly freezes in the abyssal zone. Yet, since water expands when it

freezes, circulation is maintained. Ice rises to melt at the warm surface. Lucky for us, as is the fact that most of the world's heat is stored in the oceans, and that the oceans are never still. Torn by winds, massaged by tides, they're adept at moving this heat around by means of currents like the Gulf Stream, circulating warm water from equator to pole, and cold water back again. Flowing from the Gulf of Mexico east to Europe and Africa, the Gulf Stream's south fork returns clockwise to the Caribbean; its north fork warms the west coast of Britain before, grown slow and cold, it sinks deep off Norway and returns, anti-clockwise, south past Labrador. Labrador enjoys the same latitude as southern Alaska, central Siberia, and Britain. Without the Gulf Stream, daffodils and growing crops would be in short supply in Britain. So would the British.

The seas protect us against extremes of land temperature. This has important implications, especially now, as we wonder if we're in for a new Ice Age (in fact we've been in an Ice Epoch for the last 65 million years), or a global greenhouse rich with carbon dioxide. In the latter case, enough ice is locked at the poles to produce a 200-feet worldwide rise in sea level, should it ever melt. A rise of only a few feet would produce an anorexic new slim-line Britain. Yet, despite present concern over the greenhouse effect, the Water Bill, which aims for radical changes in the current system in Britain, hardly worries itself with research into, or the cost of, strengthening coastal defences should the seas start to rise.

A team at the Lamont-Doherty Geological Observatory, studying the role of the seas in forming Ice Ages after the interglacial periods that relieve the dominant chill of the era since the dinosaurs died, has suggested that the oceans play a feedback role.[8] The start of an Ice Age, they say, is linked to cool summers and relatively warm winters: while the land cools down, the ocean stays warm, producing ample moisture to evaporate upwards and fall as snow which, with summers too cool to melt it, generates glaciers.

But this is only one theory among many. Experts seem divided as to whether we're about to freeze or boil, build igloos or arks. The latter currently seems more likely. Even Mrs Thatcher now seems to accept that the greenhouse effect is more than environmental scaremongering. If so, our grandchildren may all need water-wings, and investment in the water industry will be a matter of collective survival, not individual profit.

THE WIND AND WATER CYCLE

97 per cent of water on Earth is salt. A third of the remaining 3 per cent is frozen in glaciers and polar ice-caps. Temperate zones like Britain receive most of the rest. This rare fresh water is the most precious commodity on the planet. But it too started out saline, before being evaporated by the sun, distilled in the atmosphere, and carried to us by the winds.

At any given time there is enough water vapour in the air to provide an inch of rainfall over the entire globe. Not that it works like that. A water particle may remain in the atmosphere for ten days, travelling vast distances, before falling as rain — usually straight back into the sea from whence it came. Only ten per cent of rain falls on land.

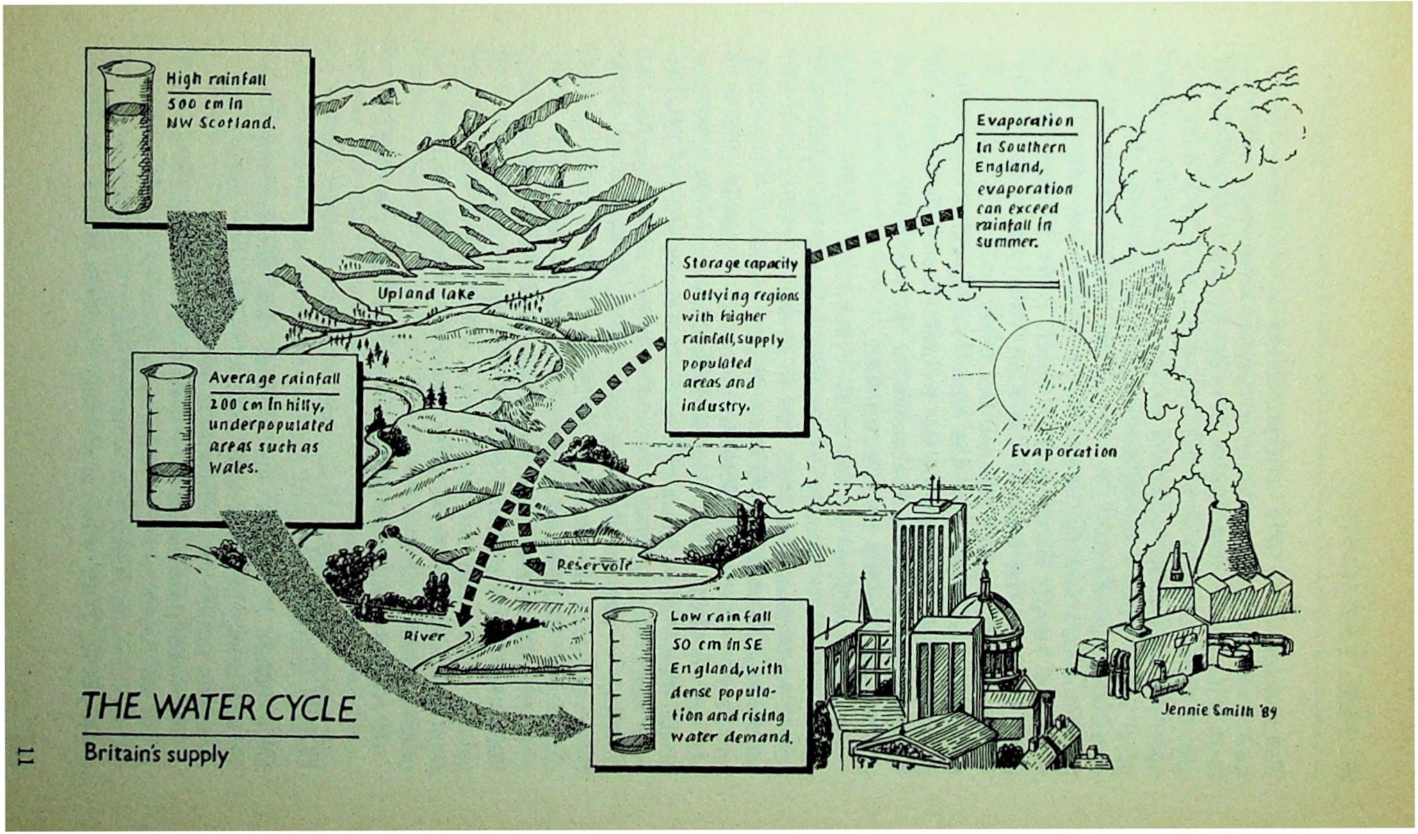
The circulation of the world's winds is too complex an affair for easy explanation. Starting round the equator, great columns of hot, moist air rise high in the sky, cooling as they go, so that the water condenses into cloud. Pushed on by more rising air below, the convection cells start moving away from the equator. At about latitude 30° — the horse latitudes — the air splits. Some whirls on towards the poles; the rest sinks to the surface, dividing again as it does, creating trade winds or westerlies.

In tropical regions weather is fairly predictable. But in temperate latitudes there is a continual war between warm tropical air and cold polar air. Meeting in *fronts*, these masses swirl into anti-clockwise vortices called *cyclones*. Other factors, including the *Coriolis effect* (causing the angled flow of winds and the gyration of currents at sea), and the way in which winds sweep inland when land warms by day and out to sea when the land cools by night, conspire to make life difficult for the poor weather forecasters we love to hate whenever they get it wrong yet again. Enough here to indicate the basic process. One, the Earth spins. Two, hot air rises, cold air sinks. Three, what goes up must come down. So that distilled, desalinated water vapour (nature invented treatment plants, we only imitate) is carried inland. It falls as rain, hail, sleet or snow.

What happens next is the subject of this book.

THE WATER CYCLE IN BRITAIN

In Britain, rainfall varies from 500 cm annually in the north-west of Scotland to about 50 cm in the south-east of England.[9]


High rainfall
500 cm in NW Scotland.
Upland lake
Average rainfall
200 cm in hilly, underpopulated areas such as Wales.
Storage capacity
Outlying regions with higher rainfall, supply populated areas and industry.
Evaporation
In Southern England, evaporation can exceed rainfall in summer.
Evaporation
Reservoir
River
Low rainfall
50 cm in SE England, with dense population and rising water demand.
THE WATER CYCLE
Britain's supply
Jennie Smith '89

The average fall in hilly underpopulated areas is about 200 cm. Most industry and population is concentrated where rainfall is least. This uneven distribution is, to say the least, awkward, and affects all water policies in the United Kingdom. For a century now, the once-great industrial centres of England have relied upon water piped from regions which may not even share the same language. Twenty years ago Plaid Cymru activists made much of this, attacking the pipelines from the Elan Valley reservoirs that supply Birmingham's water. Later a super-dam at Craig Goch at the head of the Elan Valley, intended as the largest in Europe, was planned but never built — no doubt to the relief of all who live in the narrow, steep-sided Wye Valley below. Whether the decision not to build was made because of Welsh protest, industrial recession, or the monetary exigencies of government policy, remains unclear.

Another problem is that most evaporation occurs during summer, when — usually — less rain falls. In the south-east, where population is greatest and most dense, evaporation can exceed rainfall, making efficient storage a necessity — especially nowadays, with water demand rising at a steady rate of 3 per cent a year.[10] This creates difficulties for authorities like South West Water, faced with lack of reservoir storage capacity ever since the inception of the regional water authorities (RWAs) — nine in England and one in Wales — in 1974. However, since the droughts of 1975 and 1976 water storage capacity in England and Wales has risen by about one third, from 1.5 million megalitres. Ironically, since then there has been little need for the extra capacity. Yet there it is, millions of gallons of raw and untreated water, drawn not so much direct from the sky, but from river, reservoir, spring, borehole, or underground aquifer.

In other words, water full of substances other than H_2O.

DOWN TO EARTH

Even before it reaches the ground, rain gathers impurities. Though it may be 'fresh' and 'natural' (save where human activity deems otherwise), rainwater is never 'pure'.

The word 'pure' needs to be used with care. There is no 'pure' water on Earth save the laboratory-distilled or ion-exchange-treated variety, which you wouldn't want to drink even if you could get it. 'Pure' water is not only tasteless, it lacks necessary

minerals like calcium and magnesium. Our ancestors knew this long ago (see Chapter 2). All over the world wells and springs locally famed for generations are said to promote the health of those who drink from them. Yet spas boast not 'pure' water, but specific mineral content. Such content results from impregnation of the water by soluble materials in the earth and rock through which it filters to the light of day. They may include magnesium and calcium salts (good for the teeth), which produce the hard water which is best to drink, even if it doesn't lather well. Manganese and iron also harden water, but they cause plumbing or laundry stains, and manganese-rich water tastes foul. Natural fluoride may be found, and if it is present in high concentration, disease is common among those who absorb it; e.g. 'Derbyshire neck' (goitre), bone deformity in parts of India, black teeth in Italy's volcanic regions. Hydroxides, carbonates and bicarbonates are alkaline and desirable in low concentration to balance out acidity. Sodium is undesirable, causing high blood pressure. Selenium and arsenic may occur naturally in various rock strata and turn up in deep rock wells. Cadmium, chromium, aluminium and other metals may also be present.

Viruses and bacteria infiltrate water from ground sources. Coliform bacteria in particular indicate the presence of faecal pollutants in water, though are not necessarily dangerous themselves. Such bacterial contamination will also easily affect rainwater collected from the sky but left to stand.

Also these days, silage liquor, slurry, nitrates, pesticides and a vast range of other chemicals and toxins pollute groundwater, river and sea as a result of farmland run-off or industrial dumping. Sewage is a chief pollutant.

The main impurity rainwater absorbs as it falls is carbon dioxide. The amount of it in the air increases all the time, as do the amounts of sulphur dioxide, nitrogen oxides, and hydrocarbons: the chief causes of acid rain, emitted when fossil fuels are burned without adequate control. It sometimes seems we want to convert the atmosphere back into the chemical stew it was all those hundreds of millennia ago before organic life evolved. Once fallen, the water can take on more carbon dioxide by flowing through decaying vegetation. The carbon dioxide turns to carbonic acid which, if the water then passes through granitic rocks, remains actively corrosive. Such acid water may react with aluminium, which is normally inert in the soil, to produce aluminium salts, now implicated in the destruction of

fish as well as in the premature onset of human senility.

This acidity is one reason for dosing raw water with lime. Soft or acid ('aggressive') water will strip lead or copper from pipes or tanks, creating a cocktail you don't want to drink. Some ten million people in Britain still receive their water through old lead piping. Especially if young or still in the womb, they are put at risk of brain damage, heart weakness, infertility, stillbirth, premature senility, and death.

These matters — the specifics of water in Britain today — are dealt with later on. But while still more-or-less up in the air and out to sea, let's take the story of water back to the water myths, cults and experiences of early human society, to trace the importance of water (and, its pollution) in the rise and fall of human societies, in the ages before we came to take it for granted.

2
HISTORY: FROM CULT TO CHOLERA

5,000 years before the young Charles Darwin came across sea-shells high in the Andes in the 1830s, religious cults worshipping or propitiating water divinities in all their aspects thrived throughout the world. Indeed, they haven't quite died away yet. When did you last throw a penny in a wishing well?

Water as manifested in Ocean with neither beginning nor end has always stirred human imagination with images of a primal whole, a cosmic parent. The Chaldeans and Greeks imagined an immense river, Oceanus, that girdles the entire universe. From Oceanus, embracing all earthly waters, arose even the stars, save for the Great Bear. The Norse spoke of the great serpent of Midgard that lay wrapped round the world, and shook its coils to cause tempest and flood. For, apart from creation myths, the earliest tales, from all over the world, are of the Flood. They include the Sumerian *Epic of Gilgamesh*, the Bible narrative of Noah, the Greek tale of Deucalion and Pyrrha, and the Atlantis legend, as told by Plato, who claimed that the statesman Solon had heard it from an Egyptian priest.

'You Greeks are all children,' Solon was told. 'You are all young in mind, you have no belief rooted in old tradition and no knowledge hoary with age. And the reason is this. There have been and will be many different calamities to destroy mankind, the greatest of them by fire and water. . . .'[1] And thereafter he tells the tale of the city destroyed by pride, of a land drowned beneath the waves. And still, whether the tale is true or not, people spend fortunes searching for that drowned city.

The point? As vulnerable beings we still fear the power of water and the sudden wave. Such tales still fascinate because we remain uneasily aware of the power of nature. We may no longer

view drought or flood as sent by God, but with good cause we still fear such unpredictable events. And likewise we need to respect and understand, if not fear, the watery, unpredictable, and sometimes chaotic nature of our own emotions. The ancients knew this. Flood-myth is often connected with moon-worshipping. The Chinese tell how the Moon Goddess sent her representative to repeople the world after the waters subsided. The Babylonians tell how their moon goddess Ishtar (like Hecate later in Greece, and Diana in Rome) governed rainfall and produced dew, a fertility symbol. She sent the Flood, but too late regretted the havoc she'd caused, and saved some few of her people by setting forth in a moon-boat from which, as the storm calmed: 'On the seventh day in the course of it I sent forth a dove and it left'.[2]

Noah may be a form of Nuah, another Sumerian moon goddess. The word 'ark' is cognate with the Hindu argha, a crescent, also the arc of a circle. Noah's ark is thus the boat of the new moon, riding the tides.

Whether Flood-myth is factually based or not, clearly it also refers to an intuition of psychological events that most of us now ignore. Not that all water-worshippers necessarily realised this symbolic level. The Bible represents the Noah tale as fact. The Egyptian farmer by the Nile, like the Celt seeking heroic death in battle, truly believed that on dying he'd be ferried over the waters to immortality in the Isles of the Blessed. But the more subtle Hindus, in telling of the moon taking the souls of the dead over the waters to redemption in the sun, knew that they projected a symbolic, not a physical reality. Tantric diagrams make this plain.

Whether seen as symbolic or not, the power of water-myth gripped the ancient world. After all, water made civilisation possible. The Sumerians, the earliest known society to leave written records, grew up between two great rivers: the Tigris and Euphrates. The Babylonians after them claimed that civilisation was founded by beings from the sea, the Oannes, in 'the shape of a fish blended with that of a man'.[3] Like the Hebrews (Jehovah vs Leviathan), Greeks (Zeus vs Typhon), and Hindus (Indra vs Vritra), they explained their society's very existence by the victory of the sun-god hero Marduk over Tiamat, monstrous goddess of the Watery wastes.[4]

Is this a metaphor for the learning of irrigation and other such skills? For by thus applying emergent (solar) reason, early man

tamed the chaos of waters so that desert grew fertile, harbours were dredged, water supplies were guaranteed. Without which agriculture, industry and trade could never have developed. These were marginal societies. For 3,000 years the Egyptians relied on the annual Nile floods to survive just as, far to the east, early Chinese societies depended on the Yellow and Yangtse rivers. The Chinese myth of the birth of writing (like the Babylonian tale of the Oannes) describes how a dragon crawled from the Yellow River, with the characters of the alphabet painted on its back. (Given the Chinese alphabet, it must have been a big dragon!)

So, since early times people have feared and worshipped water, for the destructive flood, tamed in well, spring or irrigation ditch, brings wealth and survival. Consider the example of Jericho. Excavation of its deepest layers shows it to have been inhabited continuously for ten millennia, thanks to a freshwater spring in a land where such amenities are scarce. This, the Fountain of Elisha, or Ain-es-Sultan spring, is now channelled to a concrete reservoir a mile north of the modern city.[5] So it goes on.

Meanwhile the echoes of water cult persist. Earlier this century the Indian folklorist R.P. Masani discovered active water worship among his countrymen when, as Municipal Secretary of Bombay, he received protests against the closure of wells due to the threat of malaria.[6] Today in Wales, over 500 wells bear the names of early saints. In Scotland, wells hung about with rags may be considered an eyesore, but remain intact due to the belief that anyone destroying the rags will take on the donor's illness. In Ross and Cromarty, the Cloutie Well near Munlochy is overhung by some 50,000 rags — people go on adding more every year. Because in Britain too the water cult prospered, and so did knowledge of water's more arcane properties, as first the Romans and then the early Christian missionaries discovered when they came to these islands.

WATER IN THE ROMAN WORLD

Rome, the last great empire of the ancient world, with its reservoirs and aqueducts which we still admire (and in some cases, still use today), ultimately fell prey not so much to invasion as to problems now all too familiar.

The Romans were well aware of the need for good water

supply and sewage disposal. The Cloaca Maxima, built in the sixth century BC to drain marshes, gradually developed into something like a modern urban sewage system. The first aqueduct brought clean water into the city in the late fourth century BC. By AD 100, ten aqueducts supplied two million people with 250 million gallons of water a day. Half this huge quantity was needed for the public baths (the baths of Caracalla could accept 1,600 bathers at a time); the rest guaranteed 50 gallons per head per day, much the same as is available to citizens in a modern western metropolis. Public toilets were easier to find in Rome then than now: the ruins of Pompeii, destroyed by Vesuvius in AD 79, reveal flushing water closets and a complex sewage system.[7] In Rome itself, public hygiene was supervised by the 'aediles', officials who combined sanitary inspection with food quality supervision.

By AD 300 Rome enjoyed public health and sanitation systems better than any to be seen anywhere again until the start of the twentieth century.

This didn't prevent disaster. The causes of disease were understood no better than the toxic effects of metals like lead. Nor was there any great understanding of ecological cause and effect. Pioneers of the modern city, the Romans also pioneered the modern contempt towards nature. For at the height of its power Rome grew its corn in the *Sahara*. What happened should warn us, just as the Dust Bowl of Oklahoma and Arkansas in the 1930s should warn those still stripping hedges from British fields. Because of changing climate, Saharan lakes began dwindling so that flora and fauna retreated, but Rome went on exploiting the vanishing wealth. As in Amazonia today, entire forests were burned off and reduced to grazing land for increasing numbers of cattle, goats, and other semi-domesticated herds. The rivers failed into salt marshes, the marshes died, salt and sand were left. Greed and the economics of mass production overcame practical reverence towards water.

Meanwhile in Rome Emperor Gordian I took five baths a day.[8] His hot water came through lead piping. Meals were cooked in lead pots. Some attribute the decline and fall of the Roman Empire to mass lassitude caused by centuries of lead overdosing. Even then some saw the danger. Pliny the Elder tried to warn his fellows that the smoke from Rome's first crude lead smelters was harmful. Ironically, his death in AD 79

resulted from acute toxic poisoning by fumes from the Vesuvius eruption.[9]

The final disaster grew out of Rome's success. Expanded trade brought not only wealth but disease. Malaria appeared in the first century BC. By AD 300 it was so chronic that life expectancy had fallen and Romans were so enervated that they were wide open not only to barbarian invasion, but to plagues that struck with ever-increasing frequency and deadliness.

Microbes, not just Goths and Vandals, destroyed Rome.

WATER CULTS IN BRITAIN

When first the Romans, then the early Christian missionaries, came to Britain, they found an island where water cults flourished. In the south east was a town the Romans called Londinium, after the local name, derived from the Celtic sun god Lug. Lug's town lay by a river called Tămēsa, named after a goddess. From south to north were many river-goddesses. There was Sabrina (the Severn), Brigantia (the Brent), and Dēvā (the Dee). There was Clōta (the Clyde, perhaps named after the hag who washes the bloody clothes of those died in battle), and the tidal wave on the Eager (Trent), to which the Roman governor had to pay respect if he wished to gather the taxes.[10] The tribes of Prytain were addicted not only to their goddesses of the rivers, but also to the numerous spirits of well, lake, and stream.

It was complex. For Britain was filled not only with rivers and lakes and streams, but with people sensitive to water deep underground. With or without bent hazel twig they could, just like the wild beasts, detect its presence. Often water found this way, and drawn up to the ground as well or spring, was thought to cure disease. Conversely, it was known that both people and beasts could be harmed if living above certain 'black' streams.

There is still no science to explain precisely this sensitivity to water and its more arcane properties, one which most of us possess, to some degree. But there are indications. Dutch geologist Solco Tromp has shown that dowsers are unusually sensitive to Earth's magnetic field, and that their responses to changes in dowsing fields can be confirmed by proton magnetometers sensitive enough to measure the magnetic field in a single atom. His experiments showed other interesting results. Mice put in an enclosure half in and half out of such a field would not sleep within it. Cucumbers, celery, onions, maize, privet hedges and

ash trees will hardly grow at all if planted above such a field.[11]

Another curiosity the Romans met in Britain was that, ages in the past, the ancient Britons had undertaken vast works, erecting tall stones above precisely those spots at which underground streams or 'blind springs' were known to exist. But nobody remembered who had done this or why. Some said the Men of the Oak, the Druids, had known — but they'd been wiped out on Anglesey by the legions of Suetonius Paulinus, or driven underground.

This British love of water lore and divinities didn't worry the pagan Romans. They liked a good bath too. The spring at Bath (Aquae Sulis) was ruled by a local goddess, Sulis. The Romans called her Sulis Minerva, and by the baths they built her a fine temple, also a healing centre. Likewise at Lydney on the Severn a healing temple was built in the late fourth century. Over 8,000 coins have been found in excavations of the baths there.

But after the legions left and the empire fell, the early Church came, and found such enthusiasm for water divinities undesirable, especially when associated with grisly practices like head worship. Not that the new Church was above water worship itself. How was Christ himself commissioned, save by a good ducking in water? A letter from Pope Gregory in AD 601 states: 'I have come to the conclusion that the temples of the idols in England should not on any account be destroyed. Augustine must smash the idols, but the temples themselves must be sprinkled with holy water. . . .'

This attitude was maintained by the Church. Rather than anger new clients, it adapted pagan practices. In France there are known to be formerly pagan sacred wells under the cathedrals of Chartres, Nimes, and Sangres; in the United Kingdom at York Minster, Carlisle Cathedral, Glastonbury and elsewhere. The Church also took credit for the healing powers of wells, real or assumed. At Llandeilo Llwydarth in West Wales, the water cured whooping cough, if drunk from a skull said to be that of St Teilo.[12] The tale of Ffynnawn Wenvrewy (Winifred's Well) tells how St Beuno cursed local King Caradog who, enraged by fair Winifred's rejection, cut off her head. Upon being cursed, Caradog 'melted into a dissolved lake'. Beuno calmly rejoined Winifred's head to her body and she returned to life, while from the spot where her blood had fallen the well sprang up.[13]

As late as 1934, villagers at Bradstone in Devon could recite doggerel about their local healing well:

If you would rise before the sun
And out to Broadstones well would run,
Wash your eyes three times and then
Leave a gift and go again,
Nor grieve for what you leave behind —
A perfect cure you will find;
A threefold journey you must take,
Before you will that cure make.[14]

All this suggests a time when the link between life, earth, and water was instinctively understood and revered. The essence of the pagan attitude towards water was that it is *alive*. In this age of pipes and pollution we seem to have forgotten all that. How did we forget?

THE MIDDLE AGES

In these latitudes, the climate of the period known as the Dark Ages may have been warmer than in recent centuries. Tales of the time suggest that wells and springs continued to be venerated not least because water grew scarce. Greater warmth is also suggested by the invasions of the Vikings from Scandinavia. Fjords melted; the sea-raiders struck as far south-east as Jerusalem, as far west as the land they called Greenland, and maybe further — until about AD 1100 the climate again chilled, stranding them back where they'd started, save for those they'd left behind in lands as diverse as Malta, Normandy, England, and Scotland.

Is it odd now that their descendants are among the most ecologically-conscious? The Norwegians, Swedes, and Danes seem unimpressed by British government excuses regarding, for example, industrial sulphur dioxide output which many blame for the acidification of Scandinavian lakes.

Early English history makes much of a king called Canute who couldn't understand why the sea wouldn't go back at his command. Maybe in fact he was engaged in a pagan water ritual subsequently misreported, much as Tudor propaganda later misrepresented Richard III. But we'll never know.

The attitudes of the Middle Ages seem odd to us now. It seems people considered cathedrals more important than sewers. But they had no option. Lacking the necessary scientific skills, they had no solution but religious faith to the terrible

problems of hygiene caused by the new explosion of city-building, trade, and large-scale warfare. When Marco Polo went to China, how could he know that a century later the trade he'd opened up would also open Europe up to the rats of the Black Death?

Diseases borne by water, whether via bacterium or human trade, have scourged humanity since people began gathering in cities. Like Athens before it, Rome had been scourged by bubonic plague already. In Byzantium in AD 542 10,000 people died daily. When it struck Europe 800 years later in 1348 it killed nearly half the continent's population over three awful years. Rumour spread that Jews had poisoned the wells. Throughout north Europe pogroms were unleashed. Thousands of Jews were burned alive in the ghettoes, or took their own lives first. The point is: many automatically assumed that water pollution was responsible. The Jews were murdered as convenient scapegoats of a mass paranoia. That in this case water pollution was not directly to blame is another of history's ironies.

The need for public hygiene, especially in cities, was not understood. Even if it had been, what could people have done? Life in medieval cities was filthy — night-soil was thrown from upper windows; open sewers ran down every street. Disease borne of this filth was spread by the movement of armies. We hear little of the fate of those armies surging continually over Europe at this time, but the fate of their leaders gives some idea. Take English monarchs alone. William the Conqueror died of a rupture of the large bowel, a result of typhoid. King John, his death romantically attributed to 'a surfeit of peaches and new cider', probably perished from a bowel rupture produced by the same disease — especially as he expired in Romney Marsh. Edward I died of dysentery, as did Henry V, and the Black Prince before him. They had no chlorine in their water then. If the high-and-mighty were so easily struck, what of the ranks? All we know is that English soldiers at Crécy in 1346 were so riddled with dysentery that the French (probably little better off) called them the breechless or bare-bottomed army.[15] Which apparently didn't stop the English winning what they called a victory. Two years later, the Black Death hit all Europe.

It's as unimaginable as Buchenwald . . . yet it was daily life. Even if they managed to get back home alive, the local water might still kill them. Matters scarcely improved over the next century or so.

THE EARLY MODERN ERA

In the late sixteenth century the famed wit Sir John Harrington was expelled from Queen Elizabeth's court for making off-colour jokes about the Queen's Privy Council. Sir John appears to have been obsessed with sewage. His anger at London's stinking streets was so great that he seriously thought of hiring a gang to fire the whole city. Burning the place down seemed to him the only solution. But he thought again, and, being an inventive man, came up with what to him seemed a more elegant answer. The water closet. (He didn't know the Romans had already invented it.)

Three hundred years before Thomas Crapper, Sir John designed the W.C. The only problem was lack of engineering know-how. Sewage systems require miles of well-manufactured, reliable pipes. Sonnets and sea-faring were within Elizabethan capacity, but not sewage systems. So Sir John's scheme died. The gentry went on walking the streets with pomades to their noses; ladies continued to balance awkwardly on pattens (stilted shoes) designed so that delicate heels should not slosh too deep in the mire, as respectable matrons from overhanging windows above continued to cry 'Gardez-loo' and launch the contents of last night's bucket. Plague continued to plague English cities, as did dysentery, typhus, typhoid, paratyphoid and the rest. . . .

Meanwhile over on the Newfoundland Banks, Dutch and English fishermen pioneered modern factory-ship fishing practices. For within a century of Columbus discovering America, the trade in salted fish was so good that every year large fishing fleets risked the month-long crossing. By burning down the shoreline pine forests to clear settlement space they released so much turpentine into the sea that the fish promptly died.

It makes you proud. . . .

THE NINETEENTH CENTURY

Cholera played a waiting game. Though known and feared in India for at least 2,000 years, it didn't appear (or reappear) in Europe until 1826. The British in India feared cholera. By the end of the eighteenth century the East India Company had lost thousands of men. The most deadly area was the GAnges delta, contaminated by religious pilgrims at Benares upstream. In 1817 a ship brought the infection to Arabia. It spread to Persia

and southern Russia. By 1829 people were dying throughout northern Europe. The first English cases appeared at Sunderland in October 1831. By 1832 North and Central America was affected in this, the first of six great cholera pandemics that ravaged the world during the nineteenth century.

One of the worst outbreaks in Britain occurred in 1849. In London, the epidemiologist John Snow (at last we are entering the 'scientific' era) concluded after long investigation that blame for the epidemic belonged to: 'the mixture of cholera evacuations with the water used for drinking and culinary purposes, either by permeating the ground and getting into wells, or by running along channels and sewers into the rivers from which entire towns are sometimes supplied with water'.[16] Snow did his research in an area round Golden Square. Water was not piped into houses: residents drew it from surface wells by hand-operated pipes. Here, the 1849 epidemic caused about 500 deaths in ten days, most fatalities being among people close to a public water pump in Broad Street. Investigating 83 deaths which had occurred over three days, Snow determined that all who had died had used this pump, and concluded, bearing in mind the general epidemic already raging, that: 'there had been no particular outbreak or increase of cholera, in this part of London, except among the persons who were in the habit of drinking the water of the above-mentioned pump-well'.

Snow represents the turnaround in our story. Though he never isolated the micro-organic cause of cholera, he established the disease as water-borne. His work encouraged other researchers whose efforts led not only to the near-eradication of cholera, dysentery and typhoid in Britain, but to the establishment of what now we know as the water industry, involved not only in the public supply of water, but also in eradicating from it the scourges that decimated past populations. Within two decades of the 1849 epidemic, the Richmond Committee (1865–67) advocated a policy of national control of water supplies. Just over a century later, following the 1973 Water Act, Britain enjoyed arguably the best public water supply system in the world.

Whether this remains true today is seriously open to question. A decade of under-investment in our public water supply and sewerage systems, coupled with massive industrial and agricultural pollution, is generating a crisis. Solution of this crisis is made more difficult by the present government insisting that any failings in the system are due to the fact that to date it has remained in

public ownership. Apparently this excuses the under-investment. The desire that private management systems should prevail seems to have overcome any practical, non-ideological approach to present environmental needs, much as the previous desire to nationalise everything did likewise. For now we have a Prime Minister who claims to have resuscitated 'Victorian values'. Apparently this means, among other things, the necessary moral precedence of an entrepreneurial approach above all other systems of social and industrial organisation.

Yet one wonders if Mrs Thatcher really understands the Victorians. They confronted a life-and-death problem which, on the whole, they solved so effectively that none of us since has had to face it. No wonder they took such pride in their water engineering, crowning reservoirs and treatment plants with elaborate architecture. They knew what they were up to. Entrepreneurial they were. But not altogether selfishly. They were improving living conditions for millions of people. They did it not out of ideological fervour but practical necessity. They were too close to deadly disease to play political games with it.

SUMMARY

The Victorians eradicated terrors which we hope will never return. Our understanding of these terrors today is limited by our lack of experience of them. Few British citizens have lived through (or died amid) health catastrophes of the sort that regularly struck human populations in the past. The nearest most of us come to such horror is via media reports of flood, famine or disease in Bangladesh or Ethiopia. Know anyone who's died of cholera, dysentery or typhus lately?

Yet such diseases will come back the moment we lower our guard beyond a certain point. Some are returning already, due not least to the increasing collapse of outdated and poorly maintained sewage systems. Leptospirosis, or 'sewerman's disease', is one. Caused by contact with rat's urine, this Victorian disease killed 15 people in Britain in *1988*.[17]

Meanwhile our apparently insatiable demand for the good life is continually growing, creating problems of pollution and the threat of strange new sicknesses on an unparalleled scale. Every year an increasing number of agricultural and industrial toxic waste products enter our water courses and get into the food chain, singly or in combination, causing a growing havoc, the full

extent of which nobody can yet estimate.

Even so, we might do well to remember that our average life expectancy is not only more than double what it was 2,000 or even 200 years ago, but over double what it is in India even now. Not though that is any cause for complacency. As we have seen, Roman life expectancy and vitality decreased even as the Empire grew to its greatest, proudest height. Its very success brought its downfall. And we might also think uneasily on the unpalatable truth that our wealth and longevity are too often bought not only at the expense of other people in other lands, but also at the expense of the flora and fauna of Britain, and of the landscape on which these rely.

3 WILDLIFE: FROM HIGHLAND TO SEA

'We thought the world belonged to us,' the Prince of Wales told delegates at the Save the Ozone Layer conference in London in March 1989. 'Now we are beginning to realise that we belong to the world. We are responsible to it, and to each other.'[1]

The world is a web. We are part of that web. Degrade it, and we degrade ourselves. Pollute water and we harm not only ourselves — in mind as well as body — but the flora and fauna that rely on it as much as we do. Ecological horror-stories in the media may suggest that water quality in the United Kingdom has declined to a point of no return. The truth is not yet so grim, and need never become so, if we learn our lesson in time. There may be individuals and organisations among us who care not a fig for a healthy environment, but they increasingly stand exposed. We all need to show respect, even reverence for nature, for Tămēsa, Sabrina, Brigantia, Dēvā, and Clōta never really died. Such reverence is based on practical necessity, not romantic ignorance. We no longer deify lake, river and sea, but the crisis we've invoked must make us wonder if our ancestors knew more about the balance, delicacy, and essential vitality of the global web than we do.

This chapter looks at our waterways and the dangers that threaten them and the higher life-forms they sustain, or did sustain. (Lower life-forms and minerals affecting the composition of water are considered in more detail in Chapter 6.)

LAKES

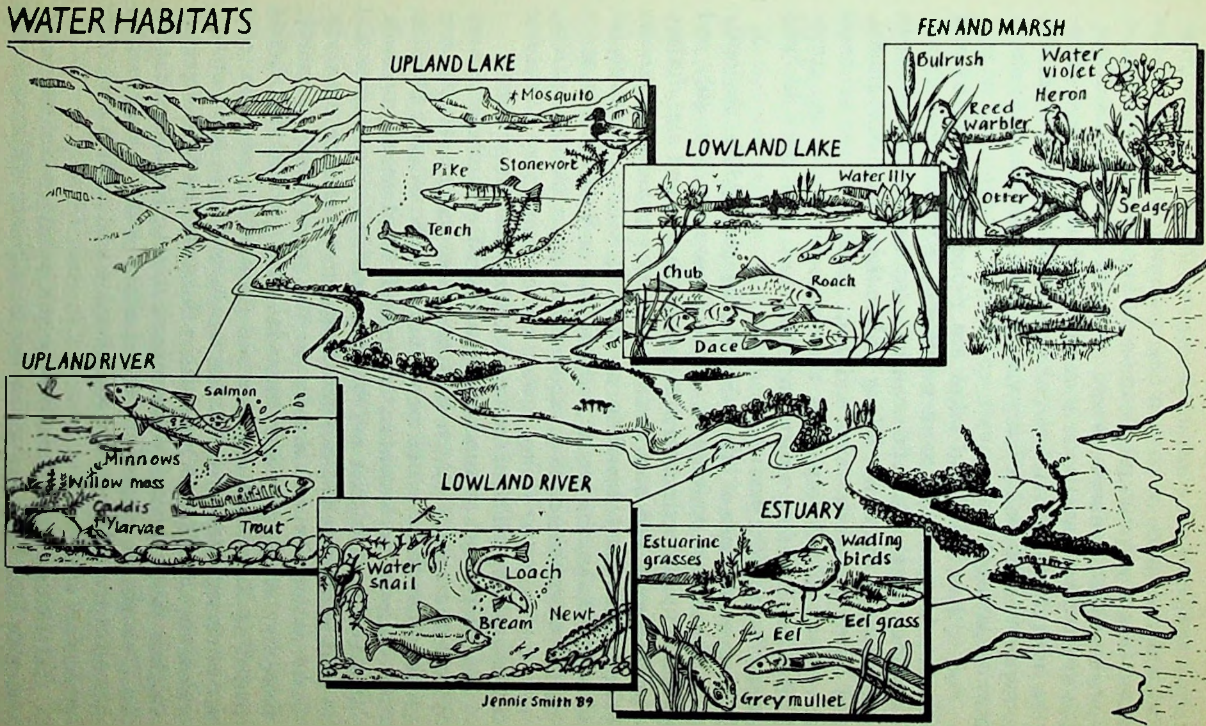
Britain's lakes come in many types, shapes, sizes and moods, from dire bare cliff-hemmed waters like Loch Coruisk amid the

Cuillin of Skye, to placid lowland lakes where yellow water-lily and the heron thrive. Covering about 1 per cent of the land surface, and found mostly in the north and the west, most lakes in the United Kingdom were glacially formed over ten millennia ago. Their chemistry, often determined by the local rock-type, ranges from acid and unproductive (*oligotrophic*), to an intermediate class (*mesotrophic*), to biologically active (*eutrophic*) water. Calcium-rich marl lakes, brackish waters, many temporary seasonal pools, and dystrophic, peaty, lifeless upland tarns are also found.

Oligotrophic waters are the most common in poor acid-soiled upland areas. These are typically clear due to the relative lack of free-floating algae. Rooted plants like stonewort grow on the bottom up to a depth of 12 feet; mud deposits in sheltered bays support shallow-water plants like water lobelia, water-lily awlwort and pondweeds. Mayfly nymphs, caddis fly larvae and snails live in the silt and mud trapped by these plants, while rush, bulrush and strands of common reed straddle the stony or coarsely-sanded shoreline. Brown trout, salmon, stickleback and el are found in deeper waters. Breeding birds that feed on hese fish and insects may include black-throated diver, goosanler, teal and mallard.[2]

Acid rain and the subsequent run-off of metals like aluminium (especially where conifer plantation is involved) constitute one danger to such waters and life they support. Another danger lies in their use as storage reservoirs or for hydro-electric schemes, leading sometimes to excessive, life-damaging falls in level. Caged fish farms, especially in the lochs and sea lochs of north-west Scotland, where some 300 exist, can cause sewage and pesticide pollution on a fatal scale. The waste from every tonne of fish produced equals the untreated sewage of several hundred people. Pesticides like Nuvan 500 and anti-foulants like TBTO (tributyltin oxide) are implicated in causing blindness in wild salmon and sterility in shellfish, while the deadly organochlorine, dieldrin, concentrates in the fat of eels.[3]

In an unspoiled lower lakeland environment the plant and animal life is richer and very different. Fish like chub, roach, dace, gudgeon and minnow feed on water fleas, flies, and many other insects, as well as yellow water lilies, various pondweeds, common reed, hornwort and bulrush. Dragonflies hover and zip in search of aquatic insects; tern hunt small fish; the heron stands silent amid reedbeds awaiting an unwary frog or newt. In



WATER HABITATS
UPLAND LAKE
Mosquito
Pike
Stonewort
Tench
FEN AND MARSH
Bulrush
Water violet
Heron
Reed warbler
Otter
Sedge
LOWLAND LAKE
Water lily
Chub
Roach
Dace
UPLAND RIVER
Salmon
Minnows
Willow mass
Caddis larvae
Trout
LOWLAND RIVER
Water snail
Loach
Bream
Newt
ESTUARY
Estuarine grasses
Wading birds
Eel grass
Eel
Grey mullet
Jennie Smith '89

winter, shallow waters attract diving and dabbling ducks, geese and widgeon graze in surrounding pastures and roost on the water. Otters may haunt both lower and upper waters so long as there is enough bankside cover . . . so long as man is not about. But everywhere the otter is in decline. Fish farmers and fishermen hunt them; in acid lochs and rivers there are no more fish to support them; in low-lying waters many pollutants similarly discourage them.

For, although lowland lakes are richer than their upland cousins, they are also more vulnerable. Fertiliser run-off can stimulate algae growth causing eutrophication (oxygen starvation) of the water, killing all but the most robust plants, and harming invertebrates and fish. Land drainage schemes drive away wildlife, especially those associated with wet grassland or fen. Breeding waders and other such birds have declined markedly in recent years.[4]

Recreational use of lakes also discourages wildlife, obviously so in the case of powerboats, which cause noise, turbidity and pollution by oil, petrol and anti-fouling paints, and also destroy aquatic plants. But even yachts or the very presence of human beings can upset breeding or nesting birds. Research at Llangorse Lake, the largest natural lake in South Wales and a typical eutrophic habitat, shows that powerboating, sailing, wind-surfing, water-skiing, rowing and canoeing play a vital role in driving away wildfowl that would otherwise winter there.[5]

Yet people seek places to play as birds seek places to nest. What's the answer? Such habitats grow scarcer, but to ban people from them would mean more erosion of civil liberties. Can we rely on voluntary restraint? This seems unlikely. Privatisation of English and Welsh water authorities is expected to lead to massive recreational development of such resources. Some authorities are already on the money-making march. Recently, Anglian Water extended the permissible fishing period on Rutland Water — a site of international importance for wintering wildfowl — into the sensitive winter period without consulting the Nature Conservancy Council. The NCC objected. Anglian Water promptly threatened to sue, claiming that the NCC sought to: 'undermine the viability of the fishing and the sale of rights'.[6] No wonder conservation and wildlife protection groups are alarmed.

Yet without human interference almost all types of lake water support life. Even temporary pools support stoneworts and

pondweeds that will reproduce before the pool dries up in summer, and many plants are equally at home in wet or dry conditions. Even brackish and calcium-rich waters have their specialised colonies. The only lake-type to be so unfriendly that little grows or lives in it is the dystrophic type and is typified by the dark highland peat-bog or lochan, where mosses, often soggy sphagnum, alone seem to thrive, save for the odd beetle scavenging on the nutrients released by decaying leaves, until a dragonfly catches it for supper.

It's eat or be eaten. We humans are the strongest eaters. The problem is that our greed may well leave us with nothing left alive to eat . . . let alone drink.

RIVERS

Rivers are arteries that fertilise the land. They too may be divided into upland and lowland types, though many are both, starting as moorland rills that join into streams that join into cold, clear torrents. Plunging down, eroding deep channels as they go, these carry humus and whatever else they come by on their journey through the varied landscapes which they've helped to sculpt over thousands of years. At last they meander through arable lands to flood plain, fen, marsh, estuary and sea.

A few rivers, mostly in the north and west, spate straight from mountain to sea. Their deep-cut channels cannot be changed save by blasting or damming. Since rarely (save for hydro-electric schemes) is there reason to do this, such rivers survive in their ancient natural course, so that migratory fish like salmon (if undecimated by disease, net or dynamite) still manage to find their way upstream to spawning grounds unchanged in ten millennia. Other rivers in the south and east not only never know hills at all, but may be so changed by human activity — dredging, drainage, banking, abstraction or pollution — that they are nothing but dirty ditches by the time they reach the sea. Great rivers like the Tyne, Mersey, Humber and Thames have been horribly polluted by industrial waste over the last two centuries. The threat of their death led to a clean-up in the sixties. It didn't last. The number of stinking eye-sores is again increasing in Britain after 25 years of improvement. By 1988, with 23,000 river pollution incidents reported (double 1982's number) 10 per cent of Britain's 27,500 miles of river and estuary water was

too polluted to support any life at all.[7] Some rivers. maybe in protest, have literally gone underground.[8]

Water Authorities Association spokesman Michael Carney, responding to a damning *Sunday Times* report on UK rivers, said in March 1989 that: '66 per cent of UK rivers are in class 1, the highest class, compared with 39 per cent in Europe. Taking classes 1 and 2 (the classes of good to reasonable quality) together, the UK figure of 92 per cent is one of the highest in Europe.'[9]

But does dying wildlife appreciate statistics? In 1987 Dr Art Lance of the RSPB reminded the Commons Environment Committee that such definition of water quality standards lacks reference to wildlife: '. . . what may be "good" in terms of existing criteria is not necessarily "good" for wildlife'.[10]

What makes our activities all the more pitiable is that life-forms in upland rivers are not weak. Their environment is harsh enough before we start meddling with it. Each species has tricks of its own to resist the strong flow of mountain streams. Mosses and ferns cling to underwater rocks amid the current. Tiny algae and diatoms film boulders with luminous green. The larvae of various flies lurk safe amid stones and silt on the river bed. Leeches use suckers; the riffle beetle uses hooks to hang on. Caddis fly larvae are ballasted, held down by small cases of stone. These inventive invertebrates survive only to feed trout, or salmon which have returned every year over thousands of miles and for hundreds of generations, fighting their way up to the very same pool.

What sort of economy is at work here? In slower gravel sections of upland rivers, grayling and minnow dine on freshwater shrimp and fly-larvae, found where plants like spanner-leaved starwort hold sand firm over the gravel. Flowering plants and mosses grow on banks which, if undisturbed, are overhung by alder and willow. Shingle banks attract oystercatchers, sandpipers, kingfisher and sandmartin; the otter slips into waters where the dipper patrols.[11]

Do we willingly see all this vanish? Few upland rivers, remote from industry, agriculture or recreation, face quite the ruin endangering many rivers in the lowlands. Yet too many have their flow controlled by hydro-electric or water abstraction schemes and have become unrecognisable. The Garry in the Cairngorms is one. Broken boulders jut naked from a tiny flow under the dam. The Beauly near Inverness is another. One of

the finest river gorges in the land is now a deep hydro-electric lake — still spectacular, still providing fishermen with sport downstream of the dam, with salmon lifts to help the fish towards the dinner table or the glass case — but no longer the same. Hill drainage and afforestation also harm upland rivers. Conifers greedily suck up all the water they can get and in return provide pulp for books like this. Deep ploughing destroys soil and soil-binding plants and darkens the clean water of spawning grounds with silt, peat, and acid-released metals that poison fish and the birds feeding on them.

Of course any long-running river deposits downstream materials it eroded higher up. Thus the Nile fertilised Egypt; thus the Tigris, Euphrates, Yellow River, Mississippi, Seine and Thames permitted urban growth on their banks. First agriculture, then industry, until the process that brings the wealth is so taken for granted that we start to abuse it. So what happens when the river, its upland rush spent, grows soft and slow as it meanders through the flatlands?

Silts collect, the water grows turbid with suspended organisms, its temperature climbs, and nowadays nitrates and phosphates infiltrate it as farms, then industrial towns appear. Discharges of chemicals, sewage, and other effluents occur. Yet in its natural state such a river is rich in life — and remains so, if respected. Flowering plants — buttercup, water crowfoot, blue water speedwell — flourish alongside chalk streams; sedges and grasses grow in profusion. Clay, silt or peat streams encourage other plants. In slower sections the arrowhead and the yellow water lily may dominate, but the white water lily is now scarce, being restricted to clean waters. Pondweeds too are in decline due to pollution or habitat destruction. All these plants provide a banquet for a host of invertebrates which in turn become the main course for minnow, stickleback, bream, roach and tench.

Yet increasingly, apart from the pollution caused by agricultural and industrial wastes that convert the river's dance of life into a graveyard, human activity not only modifies but destroys the ecological diversity of many rivers, particularly in the Home Counties and East Anglia. Deep-dredging for drainage, or navigation by pleasure or commercial craft, turns rivers into featureless channels of uniform width; riverbank flora is torn out to ease agricultural development; over-abstraction for public water supplies turns rivers into stagnant cesspits in which no life survives. The result? Loss not only of plant, animal, and other

life but, through such losses, loss of the quality of life. Who likes to live by a sewer?

FENS AND MARSHES

Much of lowland Britain was once covered by forest and swamp. Now only poor fragments remain. The forests were cut, the marshes drained. Since Roman times people have been hacking both health and wealth from plague-ridden marshes. By the end of the sixteenth century much of the fenland of Huntingdon and Cambridgeshire was already drained, a process even then causing alarm — before he became Protector of England, Oliver Cromwell was known as Protector of the Fens. Surface drainage was the usual system, but from Cromwell's time onwards farmers began experimenting with sub-surface drainage. The introduction first of wind then steam-driven pumps ended the reliance on gravity drainage, so that from 1826 to 1890 over 50,000 square kilometres (46 per cent of all agricultural land in England and Wales) was under-drained. In the period 1940-81, almost 20,000 square kilometres of wetland were drained, with government assistance.[12]

Farmers gain substantial benefits by draining land with a high water table. Crops can be planted earlier, crop and stock diseases are reduced, the grazing season is extended, soil structure improves. Such programmes also have profound social consequences. Disease is reduced by drainage, while as late as the eighteenth century the Essex marshes contained areas so remote and isolated that Christianity had not yet reached them.

But such improvements are a catastrophe for wetland birds, flora, and other fauna. Duck take most of their food from water; waders like snipe can probe only into damp soil. A fall in flooding decreases the area available for roosting and feeding, and renders waterfowl more prone to disturbance. The abundance of invertebrates falls. Increased herbicide and fertiliser use leads to poisoned, oxygen-dead water. Phosphate and nitrate run-off (most severe in East Anglia) destroys natural fen vegetation, replacing it with unlovely nettle and dock. Ploughing and reseeding with non-tussock forming grasses produces a sward unsuitable for wetland birds. The result: a huge decrease in the variety and density of breeding wildfowl. The vast scale of Victorian drainage is associated with the extinction of wetland breeding species like avocet, bittern, black tern and ruff. The breeding

population of redshank in Oxfordshire fell from 122 pairs in 1939 to just 11 in 1982. Snipe and waders have gone into steep decline throughout the country. Given that less than one per cent of East Anglia's original fenlands now remain after 300 years of drainage, such losses are no surprise.[13]

Everywhere it is the same. The main reduction in East Essex and Kent's Romney Marsh occurred in the 1940s. In North Kent and Norfolk's Broadland marshes the loss was mostly in the 1970s. Fens undrained are those which to date remain too difficult to drain. Wetlands that survive, shadows of their old selves, exist in East Anglia (the Norfolk Broads), Huntingdon, Cambridgeshire, Somerset (Somerset Levels), and Yorkshire (the Derwent Ings). Smaller fens remain relatively abundant on the Scottish and Welsh borders, also in Anglesea, Cumbria, and in Scotland's Spey Valley (the Insh Marshes). Of late the Flow Country of Caithness has been in the news: yet another area of unique ecological importance ploughed up and planted with conifers to enrich people who should know better. Must we destroy what cannot be brought back just to make money? At last (if not too late) such questions are raised by bodies like the NCC, the RSPB, the British Trust for Ornithology and others. For, as matters stand, the loss of wetlands has also lost the UK far too many species of flora and fauna.

The Norfolk Broads remain the most crucial fenland habitat. Since 1945 vast areas have been drained. Yet parts remain where, along miles of river valley, open reedswamps, sedge beds, and alder woodland are found, each the refuge of widely varied plant and bird-life. Open fen is dominated by tall, lush plants, like hemp-agrimony, hairy willowherb, valerian, and meadowsweet, and many sedges and rushes. In some areas up to fifty flowering plants may be found within a few square metres. Among these, once common but now rare, are the marsh pea, fen orchid, and helleborine — the latter once found throughout Britain. The marsh marigold too is now confined to a few small corners. As for fenland shrubs and trees, these include species of willow, alder, birch, alder buckthorn and guelder rose; species that will not root well when winter flood is regular. In such areas, open fen remains, supporting plants that rely mainly on nutrients in the water flow. Calcium-rich fens encourage mosses and liverworts, and plants like marsh orchid, butterwort, and grass-of-Parnassus. More acid water encourages bog communities dominated by sphagnum moss, and plants like marsh

cinquefoil, bogbean and bog myrtle. Surviving fenland reed-beds give refuge to birds now rare in Britain, like marsh harrier, bearded tit, and bittern. Sedge and reed-warblers, heron and moorhen are also associated with fenland; duck feed at open pools; kingfishers feed along the dykes. The Norfolk Broads and other fens also provide migratory birds with a staging post.

Other fauna too are found in preserved fenland. Roe deer graze; frogs and grass snakes are abundant. As for insects, many larvae are aquatic and cannot survive prolonged lowering of the water table. The Swallowtail butterfly and Norfolk aeshna dragonfly, both confined to the Norfolk Broads, are now protected by law, as is the fen raft spider.[14]

In areas like Norfolk some open fen is maintained to harvest reed and sedge for thatching. This helps to maintain existing populations of flora and fauna. But a commercial approach alone to these fragile habitats will not guarantee their survival. Careful conservation is needed, especially where control of water levels, often on a seasonal basis, is involved.

ESTUARIES

Likewise endangered by human enterprise are the many life-forms reliant on the specialised ecology of British estuaries — rivermouth zones where fresh and salt water mix to create tidal mudflats, their upper regions stabilised by saltmarshes, which provide a migratory refuge for birds feeding on invertebrates inhabiting the middle and lower shore.

Of Britain's 300 estuaries, a hundred are large enough to present such conditions for up to five kilometres inland. Varying in type according to river flow and tidal range, in their present shape they evolved during and after the last Ice Age. Fjord-like Scottish sea-lochs are valleys ground out by ice-action; coastal plain estuaries are old river valleys flooded by post-glacial rises in sea-level. Though many may seem to be nothing but flat, muddy wastelands, these latter are among the most biologically productive of all wildlife habitats, due to the continual mixing of tide-stirred sediment with nutrients washed in from river and sea (and from human activity).[15]

These nutrients are taken up directly and recycled by communities of specialised saltmarsh plants which, in Britain, usually remain unmodified by human management. Adapted to the often rapid changes in temperature, salinity and turbidity

which characterise the twice-daily tidal cycle, such communities grow abundantly, as do other estuarine plants like seaweeds, eel grass, and microscopic plants living on the mud and sand. The latter, filtered from the water by bottom-dwelling invertebrates like cockles and mussels, also feed minute planktonic animals: in turn these invertebrates and tiny animals, along with the larger plants, feed fish, rabbits, smaller grazing animals like winkles, and especially the huge numbers of maritime birds that roost, breed and feed in the cover of the saltmarshes.

Every year, Britain's relatively mild winters and large estuarine tidal ranges attract up to two million wintering wading birds: 40 per cent of the total number wintering in Europe. Knot, dunlin, plover, oystercatcher and curlew arrive from northern Europe, Siberia, Iceland and Greenland to patrol the shore and mudflats. In addition, up to a million wildfowl swell this wintering population, feeding and building up the fat reserves they need for further migration and subsequent return to arctic and sub-arctic breeding grounds. Swan, goose, widgeon, mallard and pintail feed on estuarine grasses and weeds; eider, scaup and goldeneye dive for subtidal invertebrates, while a range of other birds — cormorants, mergansers, grebes, divers and herons — vie with otter and grey or common seal to feed on estuarine fish.

Many of Britain's estuaries remain in a relatively natural state. But others are threatened by a range of human activities: land reclamation and tidal barrage schemes, and by sewage or industrial pollution. The worst pollution is caused by discharge of raw domestic sewage. The volume of effluent entering Langstone Harbour in Hampshire increased fivefold between 1959 and 1981, promoting green algae growth that smothered the mud-living invertebrates on which local shelduck and waders relied. These species declined. Lately Southern Water has begun stripping phosphates and nitrates from the effluent before discharge. The algal cover has been reduced and the shelduck population has recovered.[16]

Oddly enough, some birds thrive on sewage pollution. Where algae bloom does not smother the habitat, the dumping into estuaries of nutrient-rich sewage can lead to increased numbers of invertebrates able to tolerate high organic but low oxygen levels, thus increasing the food supply for shore birds, diving duck and others. Scandinavian birds return every year to Seal Sands on the Tees estuary because, claims Professor Peter

Evans of Durham University, the dumping of raw sewage has stimulated the growth of marine worms.[17] Termination of this process in the Clyde is thought to have detrimentally affected shorebirds. In the Firth of Forth, large flocks of duck (mostly scaup and goldeneye) were attracted to Edinburgh sewage outfalls between Leith and Musselburgh, but have virtually disappeared since construction of a treatment works in the 1970s.[18]

Though sewage discharge into estuaries may sometimes benefit birds, it does nothing but harm to shellfish and those who farm them. Mussels in the Wash are now so polluted they have to be purified before they can be sold. Other forms of estuarine pollution — direct industrial discharge of toxins, heavy metals, and organic compounds; oil from roads, refineries or ships; drainage from farmland of fertilisers and pesticides — do no good at all. A 1980 survey of English and Welsh estuaries by the National Water Council indicated chemical, biological and aesthetic degradation in a hundred sites; forty-five estuaries were classed as poor or bad.[19]

But even a polluted estuary remains an estuary, with the possibility of a clean-up. A more serious threat — entire destruction of the habitat — is posed by land reclamation, whereby salt marshes and intertidal mudflats are embanked and drained to create space for new agricultural or industrial development. The damage is greater when reclamation by infilling is used to dispose of refuse and other waste. Mature vegetation and life relying on it is lost through such schemes: regeneration beyond the reclaimed area is rarely extensive. But human economic interests usually prevail over the needs of wildlife. The reclamation process has been continual during the last few centuries. The 45,000 hectares of salt marsh round Britain's coast is now probably well under half what existed 500 years ago. In the Wash, 32,000 hectares have been reclaimed since the sixteenth century: 2,400 hectares of mudflats at Teesmouth in 1852 are now down to 175, and even this vital area is designated for future port development.[20] Deepening an estuary by dredging while reclamation is under way also severely modifies the habitat, while plans to barrage some of Britain's estuaries for purposes of electricity generation alarm conservationists and organisations such as the Nature Conservancy Council (NCC) and the Royal Society for the Protection of Birds (RSPB).

Tidal barrages could provide a clean, safe, and infinitely renewable source of electricity. The technique is simple. The

rising tide is let in through sluices closed at high tide. Water then flows out through turbines which generate power once a large enough head of water has developed due to the falling tide outside the barrage. But as the power thus generated is not continuous and comes in two pulses every day during part of each ebb tide, nuclear or fossil fuel stations would still have to supply an equivalent amount of electricity during the rising tide.[21] The NCC claims that not only would such barrages not be cost-effective, but that they would cause environmental problems. They would reduce tidal amplitude by up to 50 per cent, causing higher mudflats and salt marsh to dry out, subsequently to be invaded by scrub or Spartina grass — an imported species now often deliberately planted into many UK estuaries to speed up accretion for coast defence and reclamation. Meanwhile the lower mudflats and their riches would vanish under the water. Barrages would prevent free passage of migratory fish like salmon, sea trout and eels, while the reduction of water circulation behind the barrage would lead to the accumulation of pollutants due to the loss of natural flushing. The danger is that birdlife would be denied not only the estuarine territory but that all available food sources would vanish. And, with the food gone, the birds too would leave. 'It is not the case,' Dr Art Lance of the RSPB told the Commons Environment Committee in 1987, 'of just hoping that the birds behind the barrage will get up and go to the next estuary down the coastline.'[22]

Sites being considered for barrage schemes include the Severn, Mersey, Solway, Wash, Dee, Humber, Morecambe Bay, Strangford Lough and Conwy. These estuaries between them support 63 per cent of all waders wintering in the United Kingdom. Under Section 28 of the Wildlife and Countryside Acts 1981-5 many of them have been notified by the NCC as Sites of Special Scientific Interest (SSSI). Many too are designated or awaiting designation under the Ramsar Convention on Conservation of Wetlands of International Importance, ratified by the British Government in 1976; while EC Directive 79/409 on the Conservation of Wild Birds — also signed by the government — requires member states to identify and designate sites of ornithological importance, notably wetlands of international value, as Special Protection Areas (SPAs).

In all, 47 estuaries in the United Kingdom have been identified as eligible for listing under the Ramsar Convention and designation as SPAs.

By 1987, the government had listed only eight of these under the Ramsar Convention, and seven as SPAs. This tardiness directly contravenes EC law, compliance being required by 1981 under Article 18 of the Directive. As we see time and again, the present government is skilled at signing EC directives and then ducking the obligation.

The RSPB state that the government has not only 'paid little attention to the responsibilities it has accepted', but in some cases has actively promoted projects damaging to important wetland sites, such as a project to barrage the Taff Estuary, Cardiff, despite its status as a SSSI.[23] If such schemes go ahead, we may have our electricity . . . but the birds will have flown. And whether by then the government will have complied with various other EC directives it signed years ago, relating to cleaner water, cleaner beaches, improved sewage treatment and a wide range of other environmental measures, remains a matter of some doubt, even though Mrs Thatcher now claims to be greener than green.

Do you believe it? Tell it to the birds. Or to those who run the water industry.

4 THE WATER INDUSTRY

> Man has been writing cheques on an overdrawn account in a finite bank of natural resources. This surely applies to water perhaps more than any other of the basic elements of our natural environment. We have known for many millennia that we must look after our water or perish; we know at last, though not too late, that we must manage our water or suffer severe loss of environmental quality.[1]

For centuries, people regarded the misuse and pollution of water as normal, and often died young of diseases they couldn't prevent. The chimneys of the Industrial Revolution didn't help either. Pollution, smog, and acid rain increased even as cholera still ruled. Factory output in Glasgow led to salmon on the Isle of Arran in the Firth of Clyde all but disappearing as early as 1840; sediment-analysis of the Round Loch of Grannoch in Galloway in 1986 showed the rapid increase in the loch's acidity around 1850.[2]

Yet medical and engineering advances at last made real improvement possible. Since the Richmond Committee's 1867 report, the provision of water and disposal of waste has become a huge industry. Today up to 99 per cent of Britain's population receives mains water collected, treated and distributed by (in England and Wales), 10 regional water authorities (RWAs) backed by 29 statutory water companies (SWAs), or by (in Scotland and Northern Ireland) water service departments of the regional councils. Some rural areas still rely on private supplies, but these are increasingly rare. Up to 95 per cent of the population is connected to mains sewers. The RWAs were created by the Water Act 1973 (even as in Scotland the autonomous water boards were abolished). They resulted from a century of piecemeal but increasingly centralised development.

What began everywhere as community or municipal water undertakings eventually became involved first with local then central government, and with an ever more complex regulatory framework now proceeding not only from Whitehall but Brussels.

In part the story is one of ever-growing demand. Take a city like Aberdeen in north-east Scotland. Around the year 1800 Aberdeen's 25,000 people relied on wells, springs, and a local loch for fresh water. Daily use per head was about 5 litres, and no sewage system existed. But the drought of 1826, plus a growing population, led the city magistrates to start abstracting water from the River Dee, using two Watt & Boulton steam engines to pump it to a central city reservoir. At first under 6 Ml/d (megalitres a day) was needed. The pumps worked six hours daily. By 1851, serving a population of 72,000, the pumps worked 22 hours out of 24. By 1885, 120,000 people were using 27 Ml/d. Consumption per head had increased almost *thirtyfold* in under a century. Abstraction grew to 36 Ml/d: a new pumping station and reservoirs had to be built.

But that was not enough. Abstraction nearly tripled over the next hundred years, until by 1978, with Aberdeen now an oil-boom city of 190,000 people, it reached 91 Ml/d, causing such a fall in the Dee that resulting hosepipe restrictions were removed only in 1985 when abstraction was reduced to 75 Ml/d. By then, consultation with fishery authorities had led to a Water Order halting abstraction for six hours daily whenever river flow fell below 640 Ml/d, thus letting fish run upstream without gasping to a halt.[3]

This increase in demand was paralleled throughout the United Kingdom. Even now UK demand continues to grow at 3 per cent per annum; and many rivers are running dry. It seems we never tire of getting wetter . . . or dirtier.

Another factor making reorganisation necessary and inevitable was the national increase in industrial and agricultural pollution, allied with the lack of local powers to oversee or prosecute. By the end of World War II, 2,600 water supply and sewage disposal companies existed in England and Wales. Not only were they administratively unco-ordinated with regard to effective management of the water cycle; they had few powers of oversight and none at all to prevent pollution or to prosecute where necessary. By the 1950s it was clear that rivers like the Thames were dying, and not slowly. 150 years of unrestricted

industry had rendered many no better than open sewers. Farming was also — literally — a growing problem. After the war farmers were encouraged to produce more food, so as to make the United Kingdom self-sufficient in cereals.

This increased production led to increased use of fertilisers and agrochemicals. Nitrates were already a health worry. Growing crops naturally require nitrogen, phosphorus, and other elements, but in some areas the soil was becoming saturated with additives. Surveys in the United States indicate that up to 64 per cent of nitrogen added to growing crops is rejected, especially during dry spells when they can't take it on. Instead, it leaches through the soil to end up in groundwater.[4] During the late 1930s some 60,000 tonnes of nitrate were used annually in the UK. By 1986 this figure had risen to about 1.6 million tonnes. Yield had increased from two to about seven tonnes per hectare, leading, as intended, to national self-sufficiency.[5]

But at what cost? People began to ask this thirty years ago. And not only in the United Kingdom. Evidence from abroad made it clear that wealth cannot be forced from the earth without heavy payment. In the United States the Great Lakes were already a disaster area. Lake Erie was dying by overdose of nitrates, phosphates, and raw sewage. In Europe, the Rhine was so badly hit by industrial and agricultural run-off that the International Commission for the Protection of the Rhine against Pollution was formed in 1950, despite which the river's quality has continued to deteriorate.

In the UK, one catastrophe in particular focused attention on the need for greater environmental regulation. The Great Smog of London in December 1952 was both the last and worst of its kind. For five days a trick of the weather turned pollution from the city's chimneys back on the streets. The acidity of the water droplets in that fog was close to the level found in a car battery. When the smog lifted after five days, 4,000 people were dead — more than died daily at the height of the 1866 cholera epidemic.

What now seems odd is how long it took people to realise it. *The Times* reported the smog's only fatality as an Aberdeen Angus bull that choked to death during the Royal Smithfield Show at Earl's Court.[6] Only later did examination of mortuary statistics suggest links between the smog and the abnormal number of deaths that week, deaths individually recorded as due to bronchitis or heart-failure, without wider cause.

It's easy to blame our forebears for what they didn't know. What will our children say of us? The acidity of many northern lochs now is not far short of the level measured in the London Smog of 1952. Water is to be sold into the private sector, though the scope for genuine competition in supplying this most natural of all monopolies is almost nil. And how can monopoly suppliers square the demands of stockholders with the statutory requirement (Water Act 1945, Water Act 1973) to supply 'wholesome' water? Of course, 'wholesome' has not been defined by statute or precedent.

Back in the 1950s it was clear that strong measures were needed to control abuse of this natural resource, water, and to ensure that growing demand could be met without catastrophe. Studies were undertaken and Acts were passed, many of them effective. Clean Air Acts creating smoke-free zones in the cities eliminated smog. Folk could breathe London air again even as fish returned to the Thames. The Water Resources Act 1963 established licences controlling abstraction (and over-abstraction) from our rivers, and the quality at last began to improve. This improvement has been maintained . . . until recently.

Also in 1963, the British Waterways Board (BWB) was established to manage the United Kingdom's 3,200 km of canals, built in the nineteenth century but soon superseded as trade routes first by rail and then by road. For years many canals were derelict backwaters, saved from closure and restored mainly by the efforts of the Inland Waterways Association, founded in 1946. Now the BWB, under government pressure to look sharp, has begun to develop its property (worth over £1 billion) both for recreation and private bankside growth in pubs, housing and craft workshops. Such developments suggest that canal quality too must be watched, if gains of recent years are not to be lost. 'We must provide a brake on developments that are not advantageous to the canals,' says David Stevenson of the Inland Waterways Association. 'Schemes built for a quick buck on an attractive stretch of water are unacceptable.'[7]

As far as the water industry and water quality as a whole were concerned, by the early 1970s the situation had genuinely improved. A real effort was being made. National utility and public health were deemed important. *Taken for Granted*, the 1970 Jeger Report of the Working Party on Sewage Disposal, surveyed disposal methods, and emphasised the need to control water pollution and the quality of water returned to rivers, and

the need for greater re-use of water. It also emphasised the move towards amenity and aesthetic values. In 1971 the Central Water Advisory Committee issued a report, *The Future Management of Water in England and Wales,* which advised a reduction in the number of water authorities. Both reports stressed the need for forward planning and greater integration of services. That same year the government announced legislation to reorganise water services 'from the source to the tap'. Measures to cleanse the rivers, improve sewerage and sewage disposal, safeguard the nation's water supplies and make wide use of water space for recreational purposes were also to be undertaken. All of which resulted in the Water Act 1973.

THE SITUATION TODAY

This Act led to a huge reorganisation of national water supplies. 29 river authorities, 157 water undertakings, and 1,393 sewage disposal authorities were abolished and replaced by the ten autonomous regional water authorities (RWAs) on 1 April 1974. No compensation was paid for the transfer of assets such as water mains, sewers and treatment works. This, amid the current privatisation furore, encourages some local authorities to talk of contesting the sell-off in court on the grounds that the government cannot sell what it does not own. Ten years on, the Water Act 1983 led to the internal reorganisation of the RWAs, vesting control in smaller executive boards appointed direct by the Minister, and largely eliminating local authority representation.[8]

The 1973 Act also set up the National Water Council (NWC) to advise RWAs and government on national water policy, and the Water Space Amenity Commission (WASAC) to advise the Secretary of State, the NWC and the RWAs on the discharge of their respective functions. Other bodies in this network include the Central Water Planning Unit. Providing national planning capability, it works to develop water resources and quality, effluent disposal, and pollution prevention in co-operation with the Water Data Unit (WDU) and the Water Research Centre (WRC). The latter, deriving most of its finances from the industry, studies resources, quality and health, methods of treatment and distribution, and, in particular, the treatment of waste water to higher standards so that it can be re-used. The WRC also issues certificates approving materials used in domestic

water filters. However, no official UK standards exist to guarantee the quality, safety or performance of domestic filter systems — in part because it is claimed that there is nothing wrong with our water. Catch-22?

Certainly, after 1974 the United Kingdom owned one of the best public water supply systems available in terms of quality, cost, and supply. The 1976 drought taught lessons leading to increased financial and industrial efficiency (as well as to overstorage of water). But recent deterioration due to under-funding in crucial areas is so plain it takes a Mr Ridley (telescope to blind eye like Lord Nelson) to pretend to see nothing wrong at all.

Understandable, with a sale worth £7 billion in the offing.

Currently, aided by 29 private Statutory Water Companies (SWCs), the ten RWAs supply 49 million people in England and Wales (out of 50 million). 'Privatisation' means the sale of these RWAs with their assets and natural monopolies of pipeline supply and drainage. It is unclear if the sell-off will finally be a success. Not only is it hugely unpopular with the public, but fears about foreign takeover are growing, stimulated by the recent ebullient market in SWC shares. These private companies, supplying a quarter of all households in England and Wales, are governed by Acts of Parliament dating from the early nineteenth century. Statute limits the amount they can pay out in shares, stipulating that surplus be handed back to the customers via lower charges. Lately they have been aggressively 'targeted' by corporate investors. French companies (construction interests dominate) now have stakes in 16 SWCs, whose share values have grown by up to 40 times their 1987 level.[9]

The SWCs are also at odds with the government over plans to increase charges to 12 million customers by an average of 30 per cent. Some companies say charges may rise by up to 70 per cent,[10] and insist that ministers tacitly agreed to the increases during talks in November 1988.[11] Michael Howard, the Junior Environment Minister, finds this hard to swallow, at least in public. It embarrasses his government, as does the EEC warning that government-granted powers (derogations) exempting UK water companies from EEC quality standards are illegal, and may lead to action in the European Court. 'I hope that the present situation will be put right,' said Mr Ripa de Meana, the EEC Environment Commissioner, 'it is not something that allows us to sit back and watch.'[12] Following this pressure, UK

and EC officials have been meeting to ensure much tougher quality regulation than originally planned in the Water Bill. Such regulation will increase costs and make water even less attractive to the private investor.

Whatever they say in public, water industry leaders cannot feel happy about the situation. For years the industry has been squeezed between government-enforced economies and EEC quality demands. The RWAs now employ 48,491 people full-time, 6,676 fewer than in 1984. More cuts in manpower and services after flotation are seen as inevitable. So are price rises to pay for compliance with EEC regulations. The commercial development or sale of thousands of acres of RWA-owned land of ecological importance is another probability, as is borrowing on a huge scale to fund the required improvements, leading to interest repayments passed on to the consumer. And the profit motive has to be considered on top of all this. How can the need to satisfy investors square with ensuring public health? How can we trust the new companies not to cut corners in order to generate profit?

The government insists this will not happen. Maybe not. But let's look at some more figures. Between 1984 and 1988 the average annual English/Welsh domestic bill for all water charges (supply, sewerage, and 'environmental services') rose from £76.85 to £107.02. In return the RWAs and SWCs (their networks are broadly regional, based on major river catchment areas) between them supplied a daily average of 16,879 megalitres of water (1987-88). WAA figures suggest that industry is supplied with 14 per cent of all water abstracted daily, power stations with 17 per cent while about 64 per cent enters public water systems for domestic or other use. You and I and everyone use an average of 135 litres daily — a third of this by flushing the toilet. Almost another third of household use derives from the use of baths, showers, and washing machines.[13] But domestic use alone accounts for only a small part of all public water use.

Agriculture and industry are the great consumers. The production of:

- a tonne of cement requires 3,600 litres of water;
- a tonne of coke 18,000 litres;
- a tonne of paper 270,000 litres;
- a tonne of artificial silk 680,000 litres;
- and even a litre of beer requires 350 litres of water.[14]

Where does this water come from? It is abstracted from rivers, or drawn from the 545 reservoirs maintained on water authority-owned land totalling over 450,000 acres. Between them, the RWAs also own 143,337 miles of water mains, 145,842 miles of sewers, 1,502 boreholes and springs, 784 sea outfalls, and over 500 dams.[15] In short, they're not lacking for a bob or two. Declared capital expenditure of all RWAs for 1987-8 was £1,187 million. Declared net value of all assets came to £8,787 million.

Declared debt came to £5,209 million.

Your chance to invest comes soon, courtesy of HM Government. Yet, as mentioned, it remains unclear if the government actually *owns* these assets, let alone the RWAs themselves. Can you sell something you don't own? If not the government, who *does* own the water that runs through our taps and down our drains? Us? The local councils who originally invested in plant, pipeline, and sewer? Prior to privatisation, certain groups, including Birmingham City Council, are proposing litigation to decide this very interesting point, a threat unlikely to encourage investors.

In addition, there are other factors to make it unlikely that the RWAs can sensibly be seen purely in terms of profit and loss.

ENVIRONMENTAL RESPONSIBILITIES

The RWAs exist not only to provide clean water and treat sewage, but to manage the water cycle so that pollution is minimised and future supply safeguarded. By law (the Water Act 1973 and the Wildlife and Countryside Act 1981) they must exercise their functions so as to further conservation. The fulfilment of this requirement alongside making profit is a baffling dichotomy.

The RWAs also have powers to prosecute offenders under the Control of Pollution Act 1974. So do Scotland's River Purification Boards (RPBs), which were created in 1963, and may be taken as the model for the National Rivers Authority (NRA) which will supervise water quality in England and Wales after privatisation. The NRA will have powers to prosecute water companies who breach their sewage discharge consents or cause other acts of pollution. This is generally seen as an improvement over the present state of affairs whereby the RWAs, frequent polluters themselves, are supposed to prosecute polluters.

Maybe it will prove to be so, but in the 15 years since the 1974 Act, Scotland's RPBs have *never* prosecuted a regional council water service for illegal levels of sewage discharge, despite the lamentable frequency of such events.

This is not entirely due to pussyfooting or mutual back-scratching. The implementation of the 1974 Act, which extended or introduced controls to deal with pollution of rivers, coastal waters and sewers, was deferred first by Labour then by Conservative governments on the grounds of cost. For a decade it was as if the Act had never been passed.

But recently prosecutions, especially of the uncontrolled discharge of farm silage and slurry, have been stepped up. In terms of oxygen demand, silage liquor is 200 times as toxic as untreated sewage. Small amounts entering otherwise clean rivers or streams can prove devastating. Flora and fauna for miles can be killed. Human beings can contract fatal illness (though you have to die before there's a case to prove, and maybe not even then). In 1987 a total of 3,890 farm pollution incidents were reported by the ten RWAs in England and Wales, an increase of 13 per cent in one year. These led to 225 prosecutions. Silage liquor discharges constituted 26 per cent of the cases but 43 per cent of the prosecutions. Average fines varied from £141 in the South West Water region to £630 in East Anglia.[16] But in 1988, over 4,000 reported farm-pollution incidents led to less than 200 prosecutions.[17] What sort of commitment to a clean-up is that?

Not unnaturally these incidents coincided with a marked decline in British river quality for the first time in 25 years. In May 1987 an all-party Commons environment committee announced that reported pollution incidents had risen from 13,000 to 20,000 in the five years up to 1985. Their report came out the day Thames Water was fined £6,000 after admitting six charges of ammonia pollution in the Thames at Aylesbury.

The charge was brought by the Anglers' Co-operative Association —a case of the gamekeeper caught poaching? And in case one thinks farmers are the worst offenders, a breakdown of the 1988 statistics (23,253 incidents of water pollution; 1,402 serious) shows them lagging behind in third place, held responsible for 19 per cent of all reported pollution incidents.[18] The WAs just edge into second place, at 20 per cent, mostly due to illegal sewage discharges. Anglian Water Authority heads the list. About a third of its discharges continue to exceed the permitted maximum.

Way out in front, causing 37 per cent of all incidents (the remaining 24 per cent being unresolved as to source) is industry. Big Business. British Coal, British Gas, British Steel and other bulwarks of our national self-esteem are far and away the worst polluters. Is it cynical to suppose that it's easier to prosecute the individual farmer than the huge industrial complex which, even if fined, can laugh off the minuscule fine imposed and usually overturn it on appeal? The truth is: as things stand it's cheaper by far for corporations to ignore the law than to invest in anti-pollution measures. Especially when representatives of such corporations pack the boards of water authorities.

OVER-ABSTRACTION

Another increasingly serious problem is that of over-abstraction. Rivers provide a major source of urban drinking supplies. Some in the Home Counties, Yorkshire, and East Anglia — Coln, Derwent, Slea and many others — are not only rapidly declining in quality due to pollution, but are even more rapidly drying up or vanishing underground due to years of over-abstraction by the RWAs.

'There is no doubt that over-abstraction has gone on and as the water authorities are the biggest abstractors and are responsible for granting licences to other abstractors they must take the blame,' claims John Humphries, former board member of Thames Water and now vice-chairman of the Environment Council.[19]

Yet the only authority so far to admit publicly to over-abstraction is Thames Water, which plans to spend £10 million rectifying the problem in several rivers in the Chilterns and Cotswolds. £10 million! Meanwhile it emerges that RWAs plan to spend up to 5 per cent of the projected £7 billion proceeds from flotation by paying advertising and public relations firms to persuade us that the sale of British water is a Good Thing.[20]

The whole business begins to smell as bad as our sewers. For the biggest single cause of river pollution is sewage discharged by the very authorities who are supposed to keep British water clean.

SEWERAGE IN THE UNITED KINGDOM

To take the wider context first, the Control of Dumping Act 1974 demands effective controls over discharges and dumping at sea.

Enforcement provisions were brought in by the Act, stressing the need to protect the marine environment. The Mediterranean, Baltic and Black Seas were already disaster areas due to pesticides and detergents from land; effluents and discharges from ships; domestic sewage; heavy metal compounds and solid objects; dredging spoil, oil, chemical and nuclear wastes. It was and is clear that an island nation like Britain is especially at risk from sea pollution. Who wants to live amid a sewer?

Fifteen years on one might be forgiven a hollow laugh. The United Kingdom remains the only European nation still to dump untreated sewage (and low-grade nuclear waste and other pollutants) at sea. Statistics from the Department of the Environment show that Britain is the only North Sea source of sewage sludge and is the main source of all other types of contaminant discharged.[21] What kind of abnormal psychology is involved here? Is it any wonder that Britain is known as 'the Dirty Man of Europe'?

Meanwhile Britain's Victorian sewage systems increasingly endanger public health in Britain itself. Back in 1974 many UK sewers were overloaded, defective in structure, leaking and vulnerable to storm overflows of raw sewage. Over half the 5,000 treatment works taken over by the RWAs failed effluent standards. Fifteen years on, the situation is worse. An increased share of water authority investment has gone into sewerage maintenance and improvement, but tighter government controls have meant that spending in this area fell by nearly a half between 1975 and 1985.[22] A 1986 report by the National Economic Development Office (Nedo) said a minimum of £1 billion a year is needed to rehabilitate water and sewage treatment systems in the United Kingdom.[23] The Department of the Environment admits an 'unacceptable' 22 per cent failure rate of sewage works nationally. Much of this failure involves pollution caused by leaks from broken sewers, overflows from overloaded sewers, and inadequately treated sewage. In 1984–85 a total of 4,166 sewer collapses were reported by eight RWAs. But as improving the system would involve high investment costs for no financial return, the government's present response is simply to reduce the standards — making the 'unacceptable', 'acceptable' at the stroke of a pen, even as, in London and the South East, 20 per cent of water coming through household taps is estimated to consist of sewage effluents.[24] Like areas of Birmingham and Bristol, parts of London are also increasingly plagued by sewer

rats finding their way above ground through crumbling tunnels and drains. At an underground walkway near Waterloo Station pest controllers recently killed 60 rats that had been crawling over people sleeping rough. '98 per cent of the rat cases we deal with involve sewers which have crumbled,' a Lambeth pest controller said.[25] 'I think the time has come for a National Rat Month,' declared a Rentokil spokesman recently.[26] Did he have his tongue in his cheek? Or was he worried about the return to Britain of leptospirosis? Either way, no national plan for repair and reconstruction of our sewers exists. Instead, deregulation and sell-off is claimed to be the answer. Victorian values? Rats!

COST OF THE CLEAN-UP

A 1988 official survey indicated a *minimum bill of £3,350 million* for the existing water industry to clean up its act in terms of pollution control and environmental protection.[27] (Other surveys indicate a figure in excess of £6 billion.) This officially admitted bill included:

- £700 million to eliminate illegal sewage discharges by 1991 (the figure has since risen);
- £70 million a year to clean up Britain's beaches by 1995;
- £80 million over ten years to bring nitrate levels down to the EEC permitted maximum level of 50 mcg per litre of water;
- £2.5 billion over 25 years to clean up the Mersey Estuary.

The Department of the Environment, who produced these figures, admits that the industry faces other large bills, the cost as yet unknown. But what is known is the reluctance of the government to make available the cash needed to clean up our water supplies, renew our sewers, and provide better water research facilities. Might this reluctance be connected with approaching privatisation? All we can say is that pollution of our water supplies is, in many areas, on the increase, as, apparently, is government reluctance to do anything about it, even as EEC standards grow more stringent.

'We have particular problems in the UK with lead and nitrates,' states Ken Collins, Euro-MP for Strathclyde East, 'and while the Government admits the levels are too high, they won't give the local authorities the £4–6 billion it'll take to bring our water up to standard. Every citizen has the right to clean,

pure drinking water, and having agreed the EEC limits, the Government has a legal and moral duty to provide it.[28]

Indeed. But when in 1987 the European Court threatened to prosecute the UK government and water authorities over excessive levels of lead, nitrates, nitrites, aluminium and trihalomethanes in some UK supplies, the response from the government was: 'The water we drink is fine and healthy. The EC has simply set very stringent standards.'[29]

SAFE TO DRINK?

We'd all like to believe we're being told the truth. But as privatisation approaches, truth seems to grow as fluid as water itself. It's sad, but the government seems concerned more with minimising the problem and massaging public opinion than with the potential cost to public health or pocket.

In February this year Friends of the Earth publicised Water Authorities Association (WAA) documents dating from March 1988. These suggest the industry's managers are more concerned with profit than with clean water.[30] One paper, from PR firm Hill & Knowlton, proposes a media campaign to allay public worry over water quality. Suggested ploys include a wet T–shirt competition in the *Sun*, promotional material on *Eastenders*, and persuading a TV weatherman to drink a glass of good old British water on air. They raise the possibility of 'training' well-known sailors and Olympic swimmers to endorse the sell-off on TV. The campaign's objective is said to be to float all companies 'in the shortest possible time whilst minimising the political risks and the risk of investor boredom.'

Conspicuously lacking from these papers is any mention of the statutory requirement to provide a nation with 'wholesome' water. One document dated May 1988 says (in jargon so dry one might misunderstand) that the industry 'needs agreement between EC, UK and water authorities by summer 1988 on a mode of compliance which is sustainable into and beyond privatisation'. A 'mode of compliance' means persuading the EC to permit continued UK *non-compliance* with water quality directives agreed nine years ago. George Orwell must be groaning in his grave! Newspeak is alive and well. So too, it seems, is pigheadedness. Failure to comply with EC directives on water quality helped scupper the government's last shot at privatisation in 1986, and might yet do the same in 1989. Far from

backing off or accepting persuasions from the United Kingdom, the European Commission in March 1989 began a major offensive designed to compel the British government to bring our drinking water up to the standards agreed by all 12 EC countries, including Britain. This can only be regarded as necessary. For all the talk in these Water Authorities Association documents is of cost and strategy, not quality.

WA managers do acknowledge the importance of the quality of life; as one document says: 'Water is the most vital of all industries because its product is essential to life'. Come to think of it, I never thought of water as a 'product'. Did you? I thought it was a natural resource. I believed naively that the WAs exist to safeguard and supply a vital public amenity. Maybe some managers are so demoralised by a decade of monetarist 'morality' that now they can't talk any other way. They know EC refusal to compromise over water quality might wreck the flotation. They realise court cases and public controversy will deter investors. This worries them. But no worry for public health seems to deter them. These managers of the wet appear to be among the driest of the dry.

A KIT OF QUESTIONS

Given the costly tide (5 per cent of £7 billion, remember?) of propaganda already pouring over us, here are some questions we might ask before we drown in this deluge of smooth, reassuring, profit-promising PR.

If the water we drink is really so 'fine and healthy', then:

• **Why** do documents have to be 'leaked' before the true intentions of the managers and politicians entrusted with the lives of millions are made public to those millions? And **why** is a century's work to create a safe public water supply being threatened by a 'morality' that places the operation of 'market forces' above all other considerations?

• **Why**, in August 1987, did the European Court threaten action against the United Kingdom to force the government and water authorities to reduce the levels of nitrates, nitrites, lead, aluminium, and trihalomethanes (THMs) such as chloroform in our drinking water?[31]

• **Who** do we believe? The government's claim that 'only' 921,000 people in the UK get nitrate-polluted drinking water in excess of the EEC limit of 50 mg per litre? Or Friends of the Earth's estimate that nearer five million are actually affected, an estimate supported by a recent *Which*? report?[32]

• **Why** does the government claim that links between nitrate intake and 'blue baby syndrome' (methaemoglobinaemia) remain tenuous, if water authorities in the Dales, East Anglia, and parts of Yorkshire issue bottled water for babies when nitrate levels climbed too high over the EEC safety limit?[33]

• **Why** do up to ten million people in the United Kingdom still receive water through old lead piping when even minute amounts of dissolved lead are known to encourage brain damage, miscarriage, still-birth, exhaustion, impotence and early death? **Why** has the British government remained so tardy in dealing with this problem that in April 1989 the Brussels authorities started legal action against Britain over the widespread lead contamination of Scottish water?

• **Why** (despite easy access to fluoride tablets to all who want them, and despite international controversy) did the Water (Fluoridation) Bill 1985 pass into law with 399 abstentions by our MPs, permitting RWAs not only to fluoridate water supplies but to do so without telling the public? And **why** has the government agreed that the Department of Health will indemnify RWAs against costs incurred should any individual water consumer sue an RWA on grounds of ill-health or death caused by drinking fluoridated water?[34]

• **How** is it that, in October 1986, Greenwich householders found live maggots, rust and dirt flowing out of their taps?[35]

• **How** is it that, in October 1986, effluent from a Bury St Edmunds' sugar factory leaked into the River Lark, killing about 15,000 fish and involving a 20-day fight by 105 Anglian Water staff to save the river at a cost of £80,000?[36]

• **Why** does the Water Authorities Association pamphlet, which offers the last information, neglect to mention that Anglian WA itself was prosecuted for polluting the River Lark in 1987 by excess discharge from the Mildenhall sewage works, and fined £750? **Why** does the pamphlet not mention that the Mildenhall works continues to break the law by excess discharge?[37]

• **How** is it that Yorkshire Water Authority doesn't know where one-third of its sewers lie? **Why** is it that human faeces float down Bradford Beck so commonly that local people called them 'Barnsley Trout'?[38]

• **How** is it that 765 miles of the rivers draining into the Mersey Basin are now classified as too dead to support fish?[39]

• **How** is it that, one Friday morning in 1984, two million people in North Wales and Merseyside woke up to find their water contaminated by phenol, which had flooded the River Dee without anyone noticing?[40]

• **How** is it that, on 6 July 1988, 20 tonnes of alum were accidently dumped into mains water at a treatment works on Bodmin Moor, poisoning 20,000 people, causing vomiting, stomach pains, skin blisters, diarrhoea, and sore throats, and also killing some 60,000 fish? **Why** did it take South West Water five weeks to acknowledge responsibility?[41] (A more detailed account of the Camelford Incident is found on pages 81–84.)

• **Why** are many of Britain's largest firms — including British Coal, British Petroleum, British Gas, British Tissues, British Leyland, British Rail and British Creameries — allowed to flout the law by dumping illegal levels of pollutants into rivers without fear of prosecution?[42]

• **Why** is British Coal continuing to dump millions of tons of pit waste into the North Sea, despite official moves to curb this pollution which has smothered the sea bed and turned 25 miles of Durham coastline and sea into a poisoned wilderness where crabs and lobsters perish?[43]

• **Why** is the management of Sellafield alias Windscale nuclear power station permitted to continue dumping 2.2 million gallons of low-grade nuclear waste into the Irish Sea *every day*, so that it is now known as the most radioactive sea in the world?

• **Why**, if our water is so 'fine and healthy', has the Robens Institute at Surrey University, in studying British tap-water, found evidence of over 300 chemicals including not only pesticides, herbicides, industrial solvents, and other major contaminants, but also traces of man-made steroids such as contraceptive pills and drugs like Valium, Mogadon, and

aspirin? Nobody blames government or the RWAs for this — but why can't the problem be acknowledged?[44]

• And lastly, **why** does a recent *Which?* report show that a third of British citizens are unhappy with their tap water?[45] Don't they believe that British water is 'fine and healthy'? Do they doubt former Agriculture Minister Lord Belstead's 1987 claim that 'British water is safe to drink, which is more than you can say for many other countries'?[46]

5
WATER AND SEWAGE TREATMENT

The problem we face is not just environmental, nor just about water supply, cost and pollution. Essentially it is about human self-interest; about all the conflicting attitudes and points of view of which we are capable, each according to our own perspective on life. For in speaking to people about water it grows clear that opinion is as fluid as water itself. A pollution incident, which to the Green activist is a crime against the planet, may be no more than an economic embarrassment to the farmer or industrialist responsible. To the politician it's just another constituency headache. To the water authority official it's a PR problem that never existed before the current eruption of public concern over pollution and privatisation. To the man or woman in the street, if confronted by it, it may at first be no more than further proof that 'They' aren't doing their job. It's rarely personal — until one night the tap water turns turbid, or a child falls sick, or the river you love is suddenly polluted by a spillage of slurry or toxins that kill all the fish.

The following story highlights such a divergence of attitudes. SMELLY STREAM STOPS EXPANSION headlines a *Farming News* story which reports how: 'Pollution experts are baffled by contamination which makes a stream through the Palmer brothers' Northamptonshire farm run bright orange and prevents them from running more cattle. It is odds on that the stream — Drummer's Spring — is affected by waste tipping in a disused quarry but experts from the Anglican (sic) Water Authority and the county environmental health department can only say the brook water passes all the usual tests but they can't identify the organic chemical which is causing the contamination and leaving a sickly odour hanging over the spinney

through which the brook runs into the River Ise near Kettering. "If they could put a man on the moon 20 years ago, they haven't made much progress if they can't test water," said Mr Palmer.'[1]

I read this after visiting water and sewage works operated by Grampian Regional Council in Aberdeen. In the laboratory of Mannofield's modern water treatment plant I asked what the gas chromatography equipment was for, and was told it was to test for the presence of organic compounds in water — i.e., chemicals, frequently meaning pollutants of the sort that we don't want to drink or bathe in. Some 70,000 chemical compounds are now used in farming, medicine and industry; over 300 now turn up in British water; and over a thousand new cocktails are invented each year. I asked if it was difficult to analyse which chemicals are involved in any one pollution incident?

In reply it was suggested that yes, accurate analysis can be difficult and that a good field knowledge of the region — who's using which chemicals and where and why — is as important as laboratory testing. I learned that a mass spectrometer, with a data base of some 40,000 known chemical structures, is more efficient than gas chromatography . . . but costs about £100,000. Few water authorities in the United Kingdom, whether to be privatised or not, have lately been spending that kind of cash. Thus often it remains very difficult to find out what exactly is getting into the water, leading to complaints like Mr Palmer's above.

But economies are not the only problem. Lately water authorities were recommended by government to test for the presence in public water of some 27 common pesticides. Their reply that 'there are no analytical methods suitable' sounds more like: 'Even if we had the cash to spend, how could we test for thousands of new compounds escaping so rapidly into the environment that no-one can keep track of them, let alone predict how they'll combine?'[2]

As WAA documents mentioned earlier imply, water authority managers may be concerned primarily with the economics of water. The approach of privatisation in England and Wales accentuates this concern. Opinion polls suggest great public concern that, as with the NHS, private profit seems to be stealing a march on public health. Whether or not this is true, it seems obvious that the argument must change. We've spent so long disputing *private* vs *public* that as a community we risk

forgetting other more essential goals of life. Water is ultimately beyond political game-playing. But at present that's what it seems to have become in the United Kingdom: yet another political game. The water authorities and services in the UK suddenly find themselves in the forefront of a battle they chose no more than the public at large. Their business, after all, is to supply water, the life-bringer.

So let's now look at how water is gathered and treated before it comes through our taps, and what happens to it after it departs down our drains.

A MODERN WATER TREATMENT SYSTEM

The growth of water demand in Aberdeen, described on page 42, saw population expanding from 25,000 to 190,000, and abstraction from the River Dee rising from 6 Ml/d (megalitres a day) to a maximum of 91 Ml/d over 175 years.

In 1975 growing local requirements led to the design and introduction of a new scheme. This included the building of a new intake, pumping station, and bankside raw water storage reservoir at Inchgarth in the city, a treatment works at Mannofield, and a long-sea sewage outfall at Nigg Bay south-east of the city. A sewage treatment plant at Persley on Donside, north-west of the city, was commissioned in 1971, not least as a result of the Aberdeen typhoid epidemic of 1964. In general, these Aberdeen plants operate in a way typical of water and sewage treatment plants everywhere. There is an increasing standardisation of global design, with variations according to local chemical and climatic circumstances. Water is water everywhere, as is human biology — and as is industrial design and capital. Water treatment facilities in Aberdeen serve as a good example of the general process in Britain.

Inchgarth Pumping Station and Reservoir

The Inchgarth pumping station and raw water reservoir lies in suburban south Aberdeen on the banks of the River Dee. The area is quiet, with many expensive new executive homes immediately north of the reservoir. Thus the choice of a medium called 'Grascrete' for the surrounds — the concrete apron stabilising the site is perforated to allow implantation of soil and the subsequent growth of greenery. The reservoir is designed not only as a necessary public health facility, but as a potential

pleasure-ground too. Environmental planning is not ignored — it cannot be, now. Automatically operated, the station is connected by remote terminal units (RTUs) to a telemetry master station installed in the control room of the treatment works at Mannofield. Facilities for gas chlorination are included in this station, to control algae growth in the reservoir. A monitory panel/mimic linked to the telemetry system is provided for plant state display and for manual backwashing control.

The system works as follows. River water gravitates into the station via bed intakes. These contain a granular filter medium — the first stage of treatment — and consist of six reinforced concrete boxes set diagonally across the riverbed. Backwashed by 'high lift' water (see below), they deliver raw water into a pump sump. Via a second sump, the water is taken by the low lift pumps up into the bankside reservoir — which, if required, can be bypassed, the water being pumped direct to Mannofield. Once in the reservoir, to prevent stagnation, raw water is circulated round a floating, adjustable L-shaped curtain. The reservoir incorporates a flood relief structure consisting of one-way gates with flap valves. These allow river water in during flood conditions, preventing excessive upthrust developing against the impervious synthetic membrane which — like a giant bin-liner covered with sand and gravel — seals the porous bed of the reservoir. Air circulating under the membrane is released via pipes along the bank of the reservoir, preventing the formation of bubbles.

After circulating through the reservoir, water enters another sump beyond which the high lift pumps send it on to the treatment works, or backwash it throught the system, as above.

Mannofield Water Treatment Plant

A mile or so from Inchgarth, Mannofield's smart modern architecture makes it look from the outside more like a leisure complex than a water treatment works — an impression initially reinforced by the indirect lighting, colour-toned decor, and sparkling pyramidical water sculpture found in the foyer. Beyond the foyer, the Control Room — with its bank of telemetry equipment, colour graphic video display unit, keyboard and dedicated function control board — reinforces this initial impression.

We might be in the Control Room of the Starship Enterprise. There's no sense of Victorian engineering here. But step through

another door and you enter a different world: one of vast halls, gleaming machinery, and the tanks through which water is passed during the stages of treatment. The scale is huge, impressive. After all, this is where water on which thousands of people rely for continued health is treated. What counts here is not decor and gleaming paintwork, but the safety, efficiency, and cost-effectiveness of the treatment processes.

So what happens here? Simply put, the raw water pumped from Inchgarth arrives in an external balancing tank sunk in an elevated site by the main treatment building. From this tank, water gravitates through the treatment process to a clear water tank from which it passes on into mains supply.

The treatment process involves the following stages:

1. From the raw water tank (with about 80 minutes throughput capacity) the water flows by gravity to the contact tank. Here, a number of vertical, parallel buffers open alternately at top and bottom, create a rolling flow amid which chemical coagulants are added and mixed. First, lime is added to increase the pH (the index of acidity to alkalinity; 7.0 being the neutral level) to the optimum level at which coagulation can work. Combining with hardness (typically caused by calcium carbonate), the lime, held in 30-ton silos and constantly stirred with water in slurry tanks prior to addition, is added by variable-stroke speed pumps. Their stoke and speed is varied on a continuous basis by a feedback loop, automatically controlled. Manual variations can be made if necessary.

2. Next, coagulant is added to clarify silted or peaty water. Aluminium sulphate is the most often used (and controversial) coagulant; aluminium hydroxide, sodium aluminate, or ferric salts may also be used. Entering the plant in 8 per cent solution (gloves and eye protection are needed to handle the delivery hoses), the alum is stored in fibreglass-lined tanks. Dissolved in the water, in time the alum produces a floc like a large snowflake. This is sticky, carrying a charge opposite to that of the suspended sediment, thus attracting it. Alum dosage is varied according to the incoming pH.

Polyelectrolyte may also be added at this stage. This is a polymer, consisting of a chain of positively and negatively charged elements which attract calcium and magnesium in the water, thus enhancing the coagulation process. Resembling wall-

paper paste when mixed, it helps to thicken the resulting 'sludge' which is then more easily drawn off at the next stage.

At Mannofield the filters employed in this process are washed daily. The measure of colour in the water treated (the Hazen Scale defines 0 as crystal clear, 300 as very turbid) has doubled in the region over the last decade. Deep agricultural ploughing has been suggested as the cause. Whether peaty water is more dangerous to public health than the alum-dosed version remains unclear — recent contamination of Swindon and Oxford supplies by the parasite cryptosporidium may be connected to the removal of alum from Thames Water treatment processes, due to the possible link between alum and senile dementia. When alum use was resumed, cases of cryptosporidiosis dropped. (The aluminium controversy is discussed in full in Chapter 7.)

3. From the *contact tank*, coagulant-dosed water enters a hall containing *sedimentation tanks* measuring 19 by 10 metres; the water in them is about 5 metres (16 feet) deep. The water enters via central channels before being piped down and distributed over the tank bases. Floc and sediment settle over several hours, being able to rise only to the *floc blanket*. At this level the sludge is trapped and drawn into *sludge cones* — inverted cones in the tank. (Tanks at some plants, not Mannofield, also have sludge pockets along the side.) When the cones are full, a valve automatically trips, and *desludging* occurs. The settled sludge is concentrated by revolving scrapers before going off to the sewers. Remaining water overflows back to the *raw water balance tank*.

4. Clarified water above the floc blanket moves on to rapid gravity filter tanks, passing through layers of graded sand and gravel to purify it still further. Anthracite may also be used as a filter medium. Discharged through nozzles in the filter floor, the water leaves via an outlet beyond which chlorine disinfection takes place. The tanks are often backwashed to clean out the filter media. Washwater is drawn from the *clear water tank* and pumped to a separate *washwater storage tank*. The washwater is jetted in, flowing up through the sand at a rate six times the normal downward rate, raising the water level, then drained, carrying dirt away and leaving the filter media clean. Air may also be introduced at the start of the process. (In some plants

carbon filters are installed under the sand and gravel, these too requiring frequent backwash flushing.)

5. Next, *chlorination*. Whatever else may be said for or against chlorine, diseases like typhoid have all but disappeared since its first introduction to public water supplies around 80 years ago. Arguments that it causes other hazards are considered later; what must be said here is that its application requires great care.

Chlorine gas is injected — not blown, due to dangers of blow-back — into the water, taking effect in half-an-hour. *Superchlorination* is employed at Mannofield, meaning that excess chlorine is injected, to be sure of killing all bacteria. The disinfected water continues to the *clear water tank*. Here sulphur dioxide is injected to trim back the chlorine, as well as lime to ensure that the filtered water enters mains distribution at the correct pH.

Treated water usually leaves Mannofield with 0.5 mg of chlorine per litre. But recently Mannofield chlorination was reduced to 0.2 mg/l to give suitable levels in water when combined with the output from Invercannie Water Works, where *chloramination* (chlorine combined with ammonia) is used. This process reduces taste and odour in water and maintains a chlorine residual in the distribution system longer than free chlorine, which declines in efficiency both in time and in distance along the line. Chloramine is also better at stopping secondary bacterial growth in the mains, and prevents chlorine reactions with humic or fulvic acids in peaty water. But it is a delicate process. The ratio of chlorine to ammonia must be precisely calculated and maintained, or *dichloramines* can form, not only causing the water to taste foul, but also as a by-product generating nitrites — implicated in infant ill-health.

6. The water you will drink and bathe in is now in mains distribution. With minor variations throughout Britain it will have been treated in a manner similar to the above. In parts of England and Wales fluoride will be added, not to treat the water, but your body. The hazards and benefits of fluoride and other chemicals mentioned above are dealt with later.

Meanwhile, what goes in . . . must come out.

SEWAGE TREATMENT AND DISPOSAL

Before 1870 only a third of Aberdeen had sewer provision. Whole areas, as elsewhere in Britain, relied on open drains. Disease flourished. Infant mortality was considerable. Many people died in early maturity. Those who made it to the three-score-and-ten were in the minority. Open sewers contributed to a death-rate which today we find unacceptable.

Or do we? Are we so complacent about the system bequeathed to us a century ago that now, as it begins to fail, we don't want to face facts?

Aberdeen's moment of truth came in 1964. Imported corned beef led to a typhoid epidemic. One result was that the city's sewage system was seen to be ineffective. For years most of Aberdeen's sewage had been dealt with by the Northern District Sewer (built in 1901) and the Western District Sewer (1937), both discharging into the sea by Girdleness. The epidemic made it plain that solid wastes were not all being carried out to sea. Two new projects were set in motion: the Persley sewage works on the polluted River Don; and the long sea outfall at Nigg. Twenty years in the construction, the recently-opened outfall is already threatened by the possible need for expensive alteration. It discharges macerated sewage in deep water 1,800 metres out to sea. With EC prohibition of untreated sewage discharge at sea now likely, it may be that expenditure at Nigg isn't over. A treatment plant may have to be added — not only at Aberdeen but also at many other similar plants all around Britain's coasts.

Persley Sewage Treatment Works

Persley lies on the banks of the Don by Aberdeen's north-west boundary. Commissioned in 1971 for £650,000, this plant was designed to purify the industrial wastewaters and sewage of 30,000 people living in the Don Valley. One problem was the riverbank presence of two paper mills — their discharges so poisoned the river that its life was under threat.

Population growth has since required doubling the plant's original capacity. This has been done by adapting the original plant to the Wimpey-Unox oxygen activated sludge process (a lovely name!). Persley has none of Mannofield's hi-tech glamour. Sewage plants are not a subject on which many of us wish to dwell. Its drab buildings and sludge tanks remind you more of Nissen huts than of the Starship Enterprise.

The process here involves four stages: *Preliminary, Primary, Biological* and *Sludge Treatment.* There is also a Scientific Services Section to check on the various process stages and effluent quality.[3]

1. Sewage enters the works from three main sewers via a gate set to admit three times the sewer's dry weather flow. If this volume is exceeded, the excess starts to fill storm tanks. These will discharge into the Don after prolonged spate. By then the sewage is dilute. If the storm is brief, the tanks can be emptied into the system for full treatment.

Two bar screens placed across the main inlet channel catch solid or large material. Mechanical rakes pass this debris to a disintegrator pump where it is macerated then returned to the main flow, thus preventing pump blockage during later stages of the operation. Next, fine particles of abrasive grit (mainly from roads) are removed in the *vortex grit plant.* Aeration keeps light organic material suspended while the grit sinks to the bottom before being pumped out, washed, and tipped into a waiting trailer.

2. The resulting flow is divided into the two *primary settlement tanks,* long, broad, shallow tanks holding 1,136 cubic metres. The velocity of the sewage entering is slowed so that it takes between two and four hours to reach the outlet. During this time solid matter in suspension sinks as a sludge; the remaining liquid proceeds to the next stage. The sludge (5 per cent solids, 95 per cent water) is removed by travelling bridges raking the bottom with scrapers, pushing the sludge to airlift pumps that draw it off to storage tanks for further treatment. About 30 per cent of the biological load is removed here.

3. Settled sewage from the primary tanks is mixed (in a tank called the reactor) with a biologically active sludge, rich in micro-organisms and produced from the sewage itself. A gas produced in the PSA plant alongside (90 per cent oxygen, 10 per cent nitrogen; produced from air containing about 20 per cent oxygen) is fed into and dissolved in this 'mixed liquor' by mixers which keep the contents stirred up. The biomass grows continually, feeding on the sewage to form a suspended sludge. In effect, the oxygen injection creates an accelerated river environment. Cleansing processes which under natural conditions take miles

are accomplished here over a hundred yards.

Sludge passes through to the *final settlement tanks* to be separated and recycled back to the reactor. The remaining purified effluent (by now almost clear, with 90 per cent of pollution removed) passes over outlet weirs to the river. Extra sludge, always building up, is pumped away daily for treatment. The process is dynamic and must be kept balanced. Too little biomass leads to a drop in final effluent quality; too much reaches a limit in efficiency due to lack of oxygen or 'food' (settled sewage).

4. Sludge from the primary settlement tanks is thickened in two storage tanks. (In some plants — not at Persley — waste activated sludge from biological treatment now goes through a *flotation thickener.* Chemically treated, with air dissolved in the mix, the liquid passes back to the main tank. Dissolved air lifts the sludge to the top, leaving clear liquid below.) At Persley, at this stage, the sludge is again chemically treated before entering the *coilfilter,* which dries the sludge to a cake later spread on the grounds of nearby farms as a soil conditioner.

5. Routine monitoring of sewage and effluent discharges from the local factories is conducted in Persley's laboratory, along with quality control of the plant's own output, to meet River Purification Board (RPB) standards.

Aberdeen Long Sea Outfall

On a south shore just inside the city limits, the building that houses the head works of the long sea outfall at Nigg Bay also seems to suffer from the stigma attaching to this end of the business. It is not lovely. In a booklet describing Nigg, Grampian Regional Council claims that Aberdeen is 'more fortunate than cities bordering the southern North Sea, in that the sea is deeper, and the winds and currents stronger — all of which work in favour of natural dilution and dispersal of sewage'.[4] A Yorkshire Water spokesman on *The North Sea* programme spoke similarly of Scarborough's long sea outfall: 'We are very fortunate in being able to find very deep water quite close inshore,' he said, then mentioned: '. . . strong tidal currents which can carry the sewage out to sea . . .'[5]

In the case of Aberdeen, a hydrographic survey identified an offshore site 1,800 metres out in the Bay of Nigg where move-

ment of water (31 metres deep at that point) was thought to guarantee the required rapid dispersal. 1,800 metres certainly drives further offshore than many other so-called long sea outfalls in the United Kingdom. In January 1975, the construction of approach sewer, treatment plant, and tunnel to submarine outfall was approved. Work began in 1978. A decade later the plant began operation.

The process in the plant hall is continuous under all tidal conditions. Automatic at nights and weekends, it is monitored by closed circuit television. Sensors trigger gas alarms if volatile gases enter the plant. The hall is sealed; air is forced in through a ducted central column, then out through fibreglass panels and back to the outside world via activated charcoal filters. Effluent tankers dock in a reception area; their discharge is checked for toxicity before being admitted to the main system. This area is monitored by atmosphere detecting equipment. In the event of an alarm, full safety gear is worn by all technicians operating in this area.

Two main channels enter the hall through gates which automatically close in the event of power failure. The process thereafter is:

1. Coarse mechanically raked screens remove solid or large objects from the flow, which then passes to 5 mm drum screens fitted with high pressure wash sprays. The screenings are macerated and either returned to the flow for re-screening, or transferred to a secondary screen for de-watering and removal from the site.

2. Grit as small as 200 microns is settled out in *detritors*, where scraper blades gather the grit into a sump and thence to separators where organic material is taken out before the grit is removed from the site.

3. Remaining effluent proceeds through rotary strainers. Processed water returns to the spray bars described in (1). The waste continues through flow measuring channels (*flumes*), thence up to the external pump house through hinged gates by three giant Archimedes screw pumps.

4. From the pump house, waste descends a vertical shaft to the 2.5 m diameter, 2,500 m long outfall tunnel. This passes under the

sea, sands, gravel, clay and bedrock, to a 270 m long diffuser section. Ten vertical 750 mm diameter shafts, each capped by a concrete head containing four discharge ports, emerge above the sea-bed. The whole head is surrounded by a concrete collar to protect against damage by or to trawl nets.

A HEALTHY PRACTICE?

'Periodic checks will continue to ensure that no damage is being done to the environment,' Grampian's booklet on Nigg assures us.[6] We hope so. Yet here as in other areas of water invasion by biologically-active matter we just don't always know what causes damage and what does not — until, too late, unforeseen trouble looms. Toxicity can result from chemical reactions in what was not at first toxic. However technologically skilled, treatment of sewage solely by maceration is not innately reassuring. Microbes and toxins can pass through without control. Do people nowadays board planes without a baggage check? The analogy may not be as extreme as it sounds.

It should be said: these and other opinions in this chapter are my own. The water works I describe in Aberdeen is just one example. My impression throughout the tour of these Aberdeen facilities was of a thorough, conscientious operation. Poor practice is not in any way implied by the above descriptions, unless in certain respects it be the poor practice of the nation as a whole. For Grampian Region is of course part of Britain, and raw sewage discharges into the North Sea by UK water authorities and services increasingly invite criticism at home and abroad. Dumping our bodily wastes into this shallow, ailing body of water seems ultimately as self-defeating as defecating in one's bath. Fouled beaches are only part of it. The danger is increased by the stillness of this infant sea, just 7,000 years old. 'It takes three years for the North Sea to flush itself,' says Paul Horsman of the Marine Conservation Society.[7]

Yet up and down our North Sea coast the discharges continue, even as water treatment plants have to deal with an ever-greater concentration of materials not naturally present in the water to start with.

6
WHAT'S NATURALLY FOUND IN WATER

Water authorities go a long way nowadays in trying to ensure that the water we drink, bathe in, and send down our drains will neither poison our bodies nor flood our rivers or streets with disease-producing sewage. If they go far enough is a matter of dispute. The processes just described are involved, even frightening, not only in their mechanical and chemical complexity, but in the scale of the cost required to maintain them, and in the growing scale of the pollution problem we face. Because today as never before water is full not only with the natural elements, compounds, salts and organisms which have always been there, but also with an ever-greater number of toxins and chemicals — in the latter case, both those we add deliberately during water treatment, and those which enter the water cycle accidentally or as the result of vandalism or criminal negligence.

This and the following chapters examine just what *is* in our water, how it got there, and what it does to us. The latter aspect of course creates fierce controversies. An increasing body of contested evidence suggests that some disinfectants deliberately put in water may sometimes prove equally or even more dangerous to our health than the organisms or minerals they are meant to neutralise. On the other hand, few disagree about the dangers caused by toxic materials that increasingly invade water, though there is argument about the scale and precise nature of these dangers.

Water in its natural state may contain:

- organisms (plant/animal);
- minerals, compounds and salts

ORGANISMS

Water organisms occur in a bewildering variety of forms and sub-forms. Not all are harmful. Some bacteria, protozoa and fungi purify polluted water, just as some minerals, in appropriate concentration, are essential to our health. Others can be harmful. Water organisms may be classified either as part of the (1) plant, (2) animal kingdoms.

Plant forms

These include algae (including diatoms), and fungi (including moulds and bacteria).

• *Algae* form the chief group of aquatic plants both in salt and fresh water, and are found throughout the world. They range in size from tiny organisms to giant seaweeds hundreds of feet long, contain chlorophyll and other pigments and manufacture their food by photosynthesis. They thrive (especially during hot weather) in stagnant surface water, giving it fishy, grassy, or more unpleasant smells. Man is repelled by algae-rich water but animals will drink it. The presence of blue-green algae is known to have killed cattle drinking such water. Also part of the algae family, *diatoms* (more than 15,000 forms are known), exist as single cells or in groups or colonies. Their cell-walls are silica-impregnated. At times they release essential oils which give water a fishy taste.

• *Fungi* also take many forms, including moulds and bacteria. Feeding on living things or dead organic matter, they are unable to manufacture their own food, and are usually colourless. *Moulds* decompose carbohydrates such as sugars, starches, and fats, also proteins and other substances, and thrive in water with a temperature range of 27–38°C. Their presence generally indicates heavily polluted water. *Bacteria* exist in numerous forms. Among the higher are the iron, sulphur, and manganese bacteria, gaining their energy by oxidising simple inorganic substances. Lower forms may be grouped as those helpful — by feeding on waste material and helping to purify water — and those harmful to man. The latter group are mainly pathogenic or disease-producing organisms, thriving best in water of body temperature.

• *Coliform bacteria* are present in the faeces of humans, animals and birds, and also occur in soil and on some plants. Though not themselves pathogens or disease organisms, they

show by their presence that water is contaminated by animal wastes, perhaps also by disease-producing organisms of the sort that may cause hepatitis, polio, cholera, typhoid, dysentery, and various gastroenteritis infections. In contaminated water coliform bacteria are usually more numerous than the contaminating organisms. When accompanied by high nitrate and chloride levels they will tend to indicate contamination from a septic system or other pollution source. In the absence of nitrates or chlorides, lower coliform levels suggest not sewage pollution, but that dirt or surface water drainage is entering the water system at some point. The absence of coliforms is no guarantee that the water is uncontaminated.

The presence of large numbers of non-coliform bacteria (often from surface water drainage) indicates lower water quality, but in itself does not necessarily suggest the high probability of the presence of disease-producing organisms that the presence of coliforms betray. All bacteria are sensitive to the temperature and pH of water, thriving best in essentially neutral waters with a pH between 6.5 and 7.5. Some can tolerate acid water. Some are more heat-resistant than others, while, at low temperatures, some may become dormant while continuing to exist. Oddly enough, the waste products of their own growth can hamper and even poison them.

Animal forms

Numerous animal forms are found in water. Among the higher forms are fish; amphibians like turtles and frogs; molluscs such as snails and shellfish; and anthropods — lobsters, crabs, water insects, water mites and others. The endangering or actual destruction of many of these higher forms by pollution in water was considered in Chapter 3. Our concern here is with lower forms such as worms and protozoa. Again, some are helpful as scavengers, while others are possible sources of infection.

- *Worms* usually live in decomposing matter at the bottom of streams and lakes where they do important scavenging work. Rotifers are the only category found near or at the surface, living mostly in stagnant fresh water. The eggs and larvae of various intestinal worms found in man and warm-blooded animals can pollute water, but rarely cause widespread infection, being few in number and so large they are easily filtered out.
- *Protozoa* are unicellular organisms found mainly at or near the surface of water or in the ocean depths. Many live as

parasites in the bodies of men and animals. Sometimes drinking water may be infested with protozoa which are not disease-producing, but give the water a fishy taste and odour. Some are aerobic, existing only where free oxygen is available.

At present, chlorination (see elsewhere) in one form or another is regarded as the best disinfectant available for dealing with plant and animal forms in water. Ultraviolet decontamination provides an alternative to the use of germicidal chemicals, oxidants, algaecides or chemical precipitants.

MINERALS, COMPOUNDS, AND SALTS

In addition to sediments (dirt, sand and clay), minerals and their salts (often combined with other elements), are found in water. They include *aluminium; iron* (precipitated, dissolved, and bacterial); *calcium* (chalk, limestone and marble), and *magnesium* (both causing hardness in water); *manganese* and *sodium*; *chlorides* and *sulphates. Hydrogen sulphide* is sometimes present as a gas, with a characteristic smell of rotten eggs. *Nitrate nitrogen* may also be found, as well as *fluoride, selenium, chromium, cadmium, copper, mercury, lead, silver,* and others. (Aluminium, fluoride, lead and nitrates, though sometimes naturally present in water, have become problematic mainly due to human intervention, and are covered in Chapters 7 and 8.)

- *Cadmium* intake is not associated with any long-term carcinogenic effects. However when food is left to stand in cadmium-plated vessels and later consumed, symptoms of food poisoning may result, and cadmium has also been associated with damage to the kidney.
- *Chromium* too, in cases of acute poisoning, may cause kidney damage. Hexavalent chromium damages various parts of the body; trivalent chromium is considered relatively innocuous.
- *Calcium and magnesium salts* are in plentiful supply. Though not found in their elemental form in the earth, they combine with other elements in many forms. Chalk, limestone and marble are calcium minerals; gypsum is calcium sulphate; epsom salts are magnesium sulphate. When water containing carbon dioxide comes into contact with calcium and magnesium carbonates in the ground, the insoluble carbonate forms of magnesium and calcium turn into the highly soluble bicarbonates, which generally form the principal compounds of hardness

found in water. Thus water from limestone areas, especially well water, will tend to be hard due to its underground flow over rock and through sand. *Hardness* causes numerous domestic problems, such as excessive soap consumption; scums and curds forming on equipment; yellowing of fabrics; toughening of vegetables, film formation in tea; and scale formation in water heaters and pipes. In industry, hardness is undesirable for laundries, metal finishing, dyeing and textile plants, food processing, pulp and paper mills, bottle washing, photography, leather production and many others. Hardness can be removed by lime-soda softening and ion exchange softening, both of which techniques, however, rely on sodium-salt interchange. It should also be noted that hard water is the best to drink, and is the least aggressive in that, unlike acidic water, it will not strip lead or other dangerous impurities from the pipes bringing you water. In addition, these salts are, at least in moderate concentration, beneficial healthwise.

• *Chlorides and Sulphates* are found in almost all natural waters, their concentration varying according to the mineral content of the soil. In small amounts they are not dangerous; in fact, low to moderate amounts are desirable, adding palatability to water. In the United States, 250 ppm (parts per million) is recommended as the maximum concentration. Water containing calcium sulphate ions is likely to taste bitter and astringent.

• *Iron* in water can cause plumbing and laundry stains in as little as 0.3 parts per million. In soluble form it can form sludge deposits in pressure tanks, pipe lines, water heater coils and other plumbing fixtures. When found in surface supplies, the water may be very acid. Aqueous iron occurs in three forms. *Precipitated iron,* in a larger or precipitated particle size, can be trapped or filtered by various means. *Dissolved iron* is colloidal and stays in suspension due to its acidic state. It must be oxidised — by chlorination or by use of an air injector valve — before it can be trapped or filtered. *Bacterial iron,* uncommon but problematic, is caused by bacteria feeding on the iron in the well or in the plumbing system. Continuous chlorination is required to precipitate this iron so that it may be trapped or filtered.

• *Mercury* is usually found in water only in small amounts and in the inorganic form which has a low level of toxicity. The major cause of mercury poisoning is methyl-mercury. This can kill, but to date such incidents have been reported only from the ingestion of contaminated foods.

- *Selenium* is relatively non-toxic, save in high levels, though various of its compounds are poisonous to humans and animals. However there is no reliable evidence of chronic symptoms occurring from long-term low-level ingestion of selenium.
- *Silver* in large doses can be fatal to humans, but its contamination of drinking water is extremely unlikely. The main result of chronic silver intake is a permanent blue-grey discolouration of the skin, mucous membranes and eyes.
- *Sodium salts* are present to greater or lesser degree in all natural water. Extremely soluble, they do not form scale when water is heated, nor produce curd when combined with soap. High concentrations give water a bad taste, increase its corrosive action, and may be bad for the health as they are associated with high blood pressure. Reverse osmosis and demineralisation effectively remove sodium salts from water.

7 TREATMENT — OR TOXIN?

Though the situation varies from region to region, in Britain as elsewhere in the world some of the chemicals used to 'treat', 'purify' or 'clarify' public water supplies are open to question on the grounds that, though in most cases they provide undeniable health benefits, some may prove to be dangerous to the health, either if misapplied or in themselves.

The chemicals most commonly used to treat water (or our bodies via water) in the UK, though not necessarily in every region, are:

- chlorine (and chloramines);
- aluminium sulphate;
- fluoride.

Other chemicals which may be added include ferric sulphate, polyaluminium chloride, sodium aluminate, and polyelectrolytes (clarification); sulphur dioxide and sodium thiosulphate (to reduce chlorine levels), ammonia, sodium hypochlorite (disinfection); lime (calcium hydroxide), soda ash (sodium carbonate), caustic soda (sodium hydroxide), sulphuric acid (all for pH adjustment, to harden water); calgon (to soften water by attracting calcium and magnesium).

CHLORINE

This is the most commonly used water disinfectant and is usually added at sources of supply as well as at treatment plants. It effectively kills bacteria and is cheap compared with other methods. Yet it has certain disadvantages. It can interact with humic acid and other natural debris in water to produce trihalomethanes (THMs). THMs are one of the five factors

found in British water in quantities exceeding EC limits. In August 1987 Brussels threatened to take the British government to court if steps were not taken to reduce THM levels. Why? Because chloroform, the most common THM, is a serious cancer-causing agent. The Water Research Centre says that trace elements of chloroform and chlorohydrates ('knock-out drops') are sometimes found in British tap water.[1] Moreover, in interaction with phenols, chlorine can form chlorophenols which make tap water taste like TCP. To avoid such problems, chlorine may be combined with ammonia to form chloramines. By 'locking up' chlorine, the ammonia annuls these unwanted reactions. Chloramines also maintain disinfection longer and further along the distribution system — chlorine alone tends to dissolve — and will more efficiently eliminate coliform bacteria. But chloramination is a delicate process. If the ratio of chlorine to ammonia is incorrectly calculated, dichloramines may be formed. This will not only cause the water to taste foul, but as a by-product may generate nitrites which (though research remains inconclusive) have been associated with an increased incidence of stomach cancer. At the very least one may say that water with high nitrite levels is undesirable for human consumption.

Water authorities remain unanimous that, while potentially dangerous substances like THMs can be formed through chlorination, the advantages of chlorine sterilisation outweight any risks, particularly at the levels used for disinfection. Is there any cause to doubt this? A 1977 study funded by the United States Environmental Protection Agency found that people in New York counties drinking chlorinated water suffered a 44 per cent higher death rate from gastrointestinal and urinary tract cancers than those who did not.[2] Chlorine is also implicated in heart disease, though not conclusively. In 1900, before chlorination was common, 35,000 people in the USA died of typhoid, 68,000 of heart disease. In 1955, 50 people died of typhoid; 536,000 of heart disease. In 1975 almost a million US citizens died of heart disease. This period saw a massive increase in the chlorination of water supplies. Of course, any number of other factors, from changed life-styles to cholesterol, may also be implicated.

A 1972 Russian study found that men who drank water with 1.4 mg of chlorine per litre showed higher blood pressure than those drinking water containing only 0.3 mg. Other studies in the United States indicate that chlorinated water has a 'deleterious

effect' on red blood cells, damaging them so they can no longer efficiently carry oxygen to every part of the body.[3] Chlorine has also been linked to behavioural problems in hyperactive children, and it may be assumed that any medium strong enough to kill bacteria in human waste cannot be good for our intestinal flora.

The subject remains controversial. Experts don't agree. But you don't have to wait for their agreement if you're unhappy about chlorinated water — which you may well be if you happen to live close to a water treatment plant. Why? Because EEC regulations lay down a minimum concentration of one ppm (part per million) of chlorine per litre of publicly supplied water. That minimum has to apply to consumers at the end of the supply line. But chlorine being a gas, its concentration diminishes as the water progresses down the line. To ensure one ppm at the end of the line, the concentration in tap water close to the treatment plant will tend to be stronger, as may be evident in the taste.

Granulated activated carbon devices are probably the most practical and inexpensive domestic means of dechlorinating drinking water.

ALUMINIUM SULPHATE (ALUM)

This compound is leached into water from rock and soil by acid rain (and as such now implicated in the death of fish and impaired breeding success among birds). 100,000 tonnes is added to tap water in Britain every year, especially in the south-east, Yorkshire, Northern England, the Scottish Borders, and in other areas with peat-stained water. The reason is cosmetic: it is a coagulant that clarifies the water. Attaching itself to particles of organic and inorganic debris, the alum sinks with them leaving — hopefully — clear water. Usually it remains dissolved. But it can emerge from domestic taps as gobs of floc through error or if water treatment filters, or the treatment plant itself, are old.

In Cornwall in July 1988 20 tonnes of alum, tipped into the wrong tank, reached the mains supply in concentration up to 6,000 times the maximum permitted EEC level, killing 60,000 fish and poisoning 20,000 people in and around the town of Camelford. (This incident is dealt with on pages 81–84.)

For years aluminium was thought one of the least toxic of

metals. This third most common element is so much part of our daily life that our intake of it via water forms a relatively small proportion of our total intake. Many people cook in aluminium pots and drink beer or soft drinks from aluminium cans. The food industry, especially breweries and dairies, uses equipment made of aluminium on a large scale. Cakes and biscuits may contain sodium aluminium phosphate (E541) as a raising agent. Modern antacids contain a form of aluminium hydroxide that is extremely active. And every time you drink a cuppa you absorb aluminium, since some plants, notably those of the tea family, absorb it from the soil.[4]

Though intake via water is only one of many ways we absorb it, research increasingly suggests that aluminium entering us in this manner is more easily assimilated by the human body than by any other route — and is also more dangerous. Doctors have known since the 1970s that aluminium absorbed into the body can cause brittle bones, anaemia, and a form of dementia — encephalopathy — that is usually fatal.[5] More recently, aluminium has been blamed for increasing incidence of the most common form of dementia, Alzheimer's disease, and its presence in water has been established as the cause of insanity and death among kidney patients on dialysis. Dr Alex Davison of Leeds, with over 1 in 10 of his home dialysis patients suffering from 'dialysis dementia', found that only those whose tap water contained over 80 micrograms of aluminium per litre were affected.[6] In areas of Yorkshire the natural alum content in water can go as high as 3,500 mcg per litre. The EEC permitted maximum is 200 mcg per litre. Mr Nicholas Ridley, Environment Minister, recently stated that the EEC limit was set in relation to the appearance of the water, not on health grounds, and that people drinking water with concentrations of aluminium over 200 mcg are not at risk.[7] Almost all Dr Davison's alum-poisoned home dialysis patients died within five to six years. New home dialysis patients were given reverse osmosis filters to purify their tap water. All such patients today remain sane — and alive. Meanwhile the proof of a connection between aluminium and Alzheimer's disease grows stronger all the time.

Aluminium is normally inert. Only when combined with acid does it turn into soluble compounds such as aluminium sulphate. It is now known that not all aluminium is filtered out on entering the body. Some accumulates in the bones and brain and, as aluminium is neurotoxic, it destroys brain function. Thus

'dialysis dementia'. If alum in water drunk by kidney patients can harm them in months (they start to absorb it when its level in treated water reaches 14 mcg per litre) and kill them in five years, what happens to the rest of us over a period of thirty or forty years? Over 570,000 people in Britain, most of them elderly, are now classified as 'demented', costing the NHS £2 billion annually.[8]

Alzheimer's disease involves incurable damage to cortical nerve cells; autopsies have found abnormal concentrations of aluminium in some cases and recent studies confirm the link. Measurements by scientists working with Dr Neil Ward at Surrey University show that six out of 15 water board areas in England and Scotland exceed EEC aluminium limits. 'The areas with high levels correlate directly with high levels of Alzheimer's' says Dr Ward.[9] A report by Dr Chris Martyn of Southampton University backs this up; so does a report by Norway's Central Bureau of Statistics, which drew on further studies in Japan and Guam.[10] The Norwegian study was criticised at the time for its methodology, but its findings have been confirmed in a new study by staff from the Medical Research Council and the Water Research Centre. Published in *The Lancet*, it concludes: 'The risk of Alzheimer's disease was 1.5 times higher in districts where the mean aluminium concentration exceeded 110 mcg per litre than in districts where the concentration was less than 10 mcg per litre.'[11]

But does that refer to aluminium added to water, or to aluminium from other sources? One of the authors of the above study, Robert Lacey of the Water Research Centre, says: 'My hunch is that residual aluminium from water treatment is more important as it is in a less complex form.'

Another recent study, by neuroscientists at Newcastle University, says that premature babies may be at risk from aluminium as their immature kidneys cannot remove it from the food they receive.[12] This ties up alarmingly with another study led by Dr Neil Ward at Surrey, this time into the amounts of aluminium found in baby milk powder between 1986 and 1988. This study found that the average amount of milk powder a baby consumed in a day contained between 173 and 2,285 mcg of aluminium, compared with average levels of between 2 and 10 mcg in breast milk.[13]

Mr Ridley may remain unconvinced of any health risk caused by alum, but leaked minutes of a Water Authorities' Association

meeting indicate the 'growing concern' of WAA chairmen.[14] A Medical Research Council survey has also established the close connection, while Colne Valley Water Company has decided to stop using alum until the question has been resolved.[15] Other water companies and water authorities are looking into the use of ferric salts as a substitute coagulant.

Meanwhile about 50 water supplies in the United Kingdom are believed to possess official exemptions from the EEC maximum limit. About two million people in Birmingham and Tyneside receive these exempted supplies. Other affected areas include Lancaster, Bolton, Oldham, Tameside and Stockport in the North-West, plus areas of Yorkshire, Wales, and the South-West. 'As far as I am concerned our water is perfectly safe,' declared a WAA spokesman after the leak of his association's minutes.[16] Did he tell that to the 20,000 people poisoned in Cornwall? They have no way to know what the long-term effects might be. What a price to pay for pretty water!

The Camelford Incident

Mr Ridley was again in the news two weeks after 20,000 people in Cornwall were poisoned and 60,000 fish killed by the accidental discharge into mains water supplies of 20 tonnes of alum on 6 July 1988.[17]

Since it took the South West Water Authority until mid-August to admit responsibility, presumably Mr Ridley was quite sincere when he told MPs at question time on 20 July that the 2 million people (other estimates say that the real figure is over 3.5 million) in England who receive their water with aluminium concentration over the EEC limit of 200 mcg per litre (and many toxicologists consider this limit at least twenty times too high) are not at risk.[18] He dismissed any connection between aluminium and Alzheimer's disease on the grounds that only one study suggested it, and it had not been published, and therefore he could not have studied it. If Mr Ridley has changed his mind since the facts about the Camelford Incident emerged, this change of mind has not been published, and thus is not yet studied either. We assume, months later, that he is still considering it intelligently, along with many other matters relating to our water.

What happened? A relief tanker driver from ICS of Avonmouth, Bristol, delivered 20 tonnes of aluminium sulphate to the unmanned Lowermoor water treatment plant on Bodmin

Moor. Unfamiliar with the works, the driver found nobody there to check him in when he arrived outside usual working hours. Opening the gates with a key left for him (the same key also opened the reservoir hatch) he mistakenly poured the eight per cent solution into a reservoir instead of a storage container, left an unsigned delivery note, and drove away.

Within hours of the solution (approximately 6,000 times the permitted EEC maximum concentration per litre) entering the mains, 20,000 people in 7,000 households in the Camelford area were affected. Women's bleached blonde hair turned green when they washed it; tap water felt sticky and turned blue; bathing in or drinking the water led to nausea, diarrhoea, vomiting, blisters, sore throats and mouth ulcers. Dr Richard Newman, a Camelford GP, saw a child of two with a tongue so smothered in ulcers: 'it looked like sago pudding'.[19] Some passed blood, others suffered kidney trouble, or acute arthritis. Due to the acid stripping water pipes and tanks, copper levels increased threefold, lead levels fourfold.[20]

Five weeks later many still suffered from lethargy, aches, pains and arthritis. After seven weeks two-thirds of homes affected still received water with alum levels over EEC limits. Yet not until 15 August did the SWWA (after an anonymous internal tip-off) admit responsibility. Even the local health authority was slow to accept that 20,000 people really were suffering from acute metal poisoning — four months passed before a health survey of Camelford residents was undertaken. Meanwhile midwives were being assured that the poisoned water was safe to use in babies' food.

A cover-up? At the very least, there was confusion. Official denials began on 7 July, the day after the disaster. The one man to lose his job in the weeks immediately following, SWWA District Manager John Lewis, was to allege in a sworn statement that the SWWA knew of the incident in hours, but told staff (himself included) to keep quiet, and on 20 July vetoed full disclosure in favour of a newspaper advertisement disguising the extent of the danger.[21] The advertisement said that the water was 'safe to use and drink', and that the aluminium as delivered to the works was 'no more acidic than lemon juice'.

Some lemon juice! Yet, on discovering the error, the SWWA had moved quickly, flushing the mains out into the rivers Camel and Allen. 60,000 salmon and trout promptly died. Men in full chemical protective suits were seen pulling them out. But still

the authority denied any problem.

Biologist Douglas Cross and others, incensed by official indifference, formed a local action group, the Camelford Advisory Scientific Panel. By mid-August they knew that, of 1,200 people in Camelford, 70 per cent showed symptoms of poisoning. The Department of the Environment refused to help, so they had to set up blood tests themselves. Official interest in possible long-term harm has since remained conspicuously lacking, despite worldwide interest in the suspected link between aluminium poisoning and brain damage. In Ridley's Wonderland, it seems, ignoring a catastrophe means it never happened. Yet again, the Nelson Syndrome — a telescope to a blind eye.

The SWWA offered all consumers a 10 per cent rebate on their annual water bill. Mr Cross pointed out that: 'The authority made £33.5 million last year, so the rebate represents about eight hours' profits for them'.[22] By December 1988, lawyers were preparing for a long compensation battle through the courts for some 170 litigants. Another 100 people, who were not pursuing legal action, had by then received some £26,000 between them from the authority.[23]

Perhaps most bizarre of all, a loophole in the 1974 Pollution Act meant that the SWWA could be prosecuted only for poisoning fish, not people. A confidential draft of the Water Bill leaked to *The Observer* suggested that the government meant to continue this anomaly on privatisation. 'Under the draft bill,' Andrew Lees of Friends of the Earth has said, 'massive private companies will be able to poison the water of entire cities without being prosecuted. But someone who fails to repair a dripping tap, or takes a kettle of water to a neighbour who has been cut off because she cannot afford to pay the bill, can be taken to court and fined.'[24] Yet now it looks as if other grounds (criminal negligence) will lead to prosecution of the SWWA, while EEC pressure has already made the government modify its plans to protect water utilities from consumer complaint.

The Camelford story doesn't end there. During the following months nearby villages suffered four mains bursts. Further contamination was dislodged. Local residents found the SWWA reluctant to give results of samples taken from their taps after the bursts. Some said the SWWA told them that their samples had been accidentally smashed and lost. The authority denied such accidents, claiming that tests showed only two homes out of 300 still over the limit.[25] Yet illness persisted. By early December Dr Richard Newman had seen ten elderly patients

struck by arthritis and another eleven by short-term memory loss. 'I have been a GP for many years,' he said, 'and in the last 20 I have only seen three cases of memory loss before.' Meanwhile an SWWA spokesman maintained that: 'There is no danger to Camelford residents in drinking the water.'[26]

I wrote to water authorities and services and asked the following question: 'In the light of the Camelford incident of July 1988, does the public have reason for concern about the quality of water supply throughout Britain as a whole, or are such events more sensibly considered as being "one-off" accidents?'

One reply seems to sum it up. 'The Camelford incident was an accident brought about by human frailties. It has highlighted faults and practices which no doubt existed at many treatment works. Safety improvements in a whole range of industries have only been introduced after accidents which were never foreseen.'[27]

The Technical Director of an English water authority wrote to say that: 'I am quite convinced that the water in England remains the safest in the world and I do not think that the Camelford incident in any way changes this view. That particular event was a "one off" but, unfortunately, a world relying heavily on an individual can always be subject to human error.'[28]

Fair comment. But doubts about alum grow. By late 1988 several water authorities, including Thames, had switched to other coagulants due to the possible link between alum and Alzheimer's disease. Ironically, this well-meaning policy change may have contributed to a new health risk. In early 1989 many people in the Swindon and Oxford areas fell ill after drinking water infected by the parasite cryptosporidium, which enters water via the faeces of young cattle discharged into rivers as slurry. The use of less effective coagulants was cited by some as a contributory factor. When Thames resumed alum treatment, the number of cases fell.

It seems we can't win. Using alum may lead to brain damage. Not using it may lead to diarrhoea and possible fatal illness.

FLUORIDE

This is the generic name for salts derived from the gas fluorine, which may occur naturally in some water in concentration rarely higher than 0.2 ppm. Though not an essential nutrient, in some

countries it may be artificially added to water on (disputed) grounds that, at an arbitrary level of one part per million, it safely combats tooth decay. But all the evidence suggests that it is a cumulative toxin, not beneficial, but harmful to health. Many authorities insist that organic fluoride, as it occurs in vegetables, fruits, nuts and seeds, is the only form the human body can safely tolerate. Thus fluoridation, described by Dr John Yiamouyiannis, a biochemist at the University of Chicago, as: 'the greatest medical fraud of the century', has stimulated bitter controversy ever since introduced to some US water supplies in the United States in the 1930s.[29]

Those opposed to its use suspect it not only of being dentally useless, but also (at higher concentrations) of causing mottled teeth, injury to the brain and nervous system, bone deformity, and potentially fatal diseases including arthritis, allergies, duodenal ulcers, cancerous and diabetic conditions. It is associated with goitre ('Derbyshire neck') and disorders of the personality, while recent Australian investigations into kidney failure claim that 63 per cent of such failures are fluoride-related. Such controversy makes it hard to see why it was introduced to water at all, especially with fluoride tablets freely available at any chemist. The tale of its admission to public water supplies throws chill light on the motives of those who unequivocally support its use.

Environmental damage caused by industrial waste fluorides as used in aluminium smelting, brick making, oil refining and phosphate fertiliser manufacture, had led to successful court actions in the United States against the companies involved. Accepting unsure evidence of improved dental health in naturally fluoridated areas, some local authorities were persuaded to buy these wastes for addition to public water. Producers like ALCOA (Aluminium Company of America) thus found a market for waste which otherwise they'd have had to clean up, forcing the public not only to drink it but (more to the point) also foot the bill for diluting fluoride to 1 ppm.[30] So the profit motive, not better public health, is implicated from the start.

In the early days fluoride was added to water in the form of sodium fluoride. Apart from its industrial uses as given above, sodium fluoride is also found in rat poison. What's bad for rats is good for us. Really? Fluoride added to UK water now is manufactured mainly by the phosphate fertiliser industry. Does that make you feel any happier?

Though its use is now banned, discontinued, or never was practised in many countries, including (in Europe) France, Greece, Holland, Hungary, Italy, Sweden and West Germany, in the UK fluoridation was introduced in 1955, and for 30 years unlawfully encouraged by successive governments and was at last given a statutory basis by the Water (Fluoridation) Act 1985. More recently, it was agreed that the DHSS should indemnify water authorities against costs incurred should any consumer sue them on grounds of ill-health or death incurred by drinking artificially fluoridated water at the recommended dosage (1 ppm). But indemnification does not cover authorities in the event of prosecution following the death or ill-health of one or more consumers through overdosage or negligence by members of water authorities' staff. This has led to a stand-off between government and water authorities, none of whom are prepared to consider new requests for fluoridation. In fact, no new fluoridation schemes have been agreed since 1982. All current schemes in England and Wales were in operation or agreed by 30 October 1985, when the Act became law.[31]

The 1985 Act followed the prosecution of Strathclyde Regional Council in 1983. Lord Jauncey's judgement declared fluoridation of water illegal. So legislation was deemed necessary. Why and by whom? Your guess is as good as mine. In the subsequent Commons debate MPs holding office were told not to vote against the Bill. Nicholas Fairbairn, former Solicitor General for Scotland, now Conservative MP for Perth and Kinross, has said that office holders voted for it: 'against their consciences in order to keep their beloved offices, cars and salaries'.[32] 399 MPs abstained from voting.

The Act thus passed not only legalised fluoridation but established precedent for bodily treatment without consent. Two former Tory Health Ministers, Sir Gerard Vaughan and Sir Geoffrey Finsberg, who backed fluoridation while in office, later condemned it and demanded that it be stopped. What do they know that the rest of us don't? Without a Freedom of Information Act we're likely never to find out. 'The sheer irresponsibility in the dental and medical profession about this problem is frankly frightening,' MP Ivan Lawrence said in Parliament in 1978 — but when it came to the vote his voice was a voice in the wilderness.[33]

There is no fluoridation of water in Scotland now; in England and Wales, the case is (as so often) different. Residents of

Birmingham, South Staffordshire, Newcastle and Gateshead, West Cumbria, mid Cheshire, Anglesey, South Wales, Lincolnshire and other areas are forced to consume fluoride whether they want to or not.

A black comedy? People in parts of Italy might say so. Their teeth are literally black as a result of excessive natural fluoride intake. As for the failure of MPs to stand up to the issue, their spines are no weaker than those of people living by Hyderabad in India, where fluoride poisoning (its presence in the water varies between 3.5 and 6 ppm) has caused bone deformities so extreme that some people cannot stand upright. The study of similar cases in the Punjab has revealed that fluoride's toxicity decreases when calcium and magnesium are also present.[34] Fluoride's effect on the thyroid, causing goitre ('Derbyshire neck'), has been observed in areas where fluoride in the water is well below the 'acceptable' one ppm.[35] A survey in four US states disclosed a higher proportion of Down's Syndrome births in towns with higher amounts of fluoride in the water. The probability that this is not due to chance was estimated as 1,000 to 1.[36] And in Eire, where fluoridation is compulsory, there is a high incidence of Down's Syndrome.[37] In 1978 a US judge banned fluoridation in Pittsburgh on the grounds that a definite link with cancer had been established.[38]

A 1985 study by three scientists at the Department of Chemistry of the University of California, San Diego, confirmed the long-held suspicions of other researchers in the Soviet Union and at King's College in London when they provided firm evidence of a mechanism whereby fluoride damages bodily enzymes and DNA. They used X-ray analysis to compare the structure of a fluoridated enzyme with that of a normal one, reporting that 'fluoride switches off the enzyme by attacking its weakest links.' Especially significant is the fact that the enzyme featuring in the San Diego study is cytochrome C oxidase — the same oxygen-carrying respiratory enzyme a deficiency of which is linked to cancer, cot death, Down's Syndrome and other infant tragedies.[39]

Author Doris Grant wrote an open letter drawing attention to this and other research to the Minister of Health for Scotland and the Secretary of State for Scotland, where (as in Eire) infant incidence of foetal defects, including spina bifida, is much greater than elsewhere in the UK, not to mention most other developed countries — so much so that the frequent occurrence

of serious deformities of the central nervous system is known as 'the Celtic Curse'. In reply, she received a statement to the effect that nothing in the San Diego study 'would change the government's conviction that fluoridation is safe.'[40] Here in Scotland we may at least be glad of Lord Jauncey's judgement.

The worst of it is that the dangers of fluoride were acknowledged long before it was ever introduced to British water. As long ago as 1924 a United Kingdom Government Departmental Committee on the use of preservatives in food reported fluorides not only to be as poisonous as formaldehyde, but placed it in the most poisonous group of all substances considered. Since then, the use of fluorides in food has been prohibited in the UK (with a limited exception for baking powders). However, British Food and Drug laws conveniently exclude water from the definition of food.[41]

Meanwhile the claim that fluoride reduces tooth decay remains dubious. In 1985, Watford's District Dental Officer reported that, after nearly 30 years of fluoridation, the health authority had no evidence of any positive effect. And in 1986, after 21 years of fluoridation, the South Birmingham Health Authority approved a health strategy aimed at reducing unacceptably high levels of dental disease. Surveys conducted over the last three years in fluoridated Anglesey, Newcastle-upon-Tyne, and the West Midlands show 55 per cent of five-year-olds to be caries (tooth decay) free. Yet in 1981 in non-fluoridated South West Avon 66.5 per cent of five-year-olds were caries free; in 1980 in non-fluoridated West Sussex and South West Thames 61 per cent and 62.6 per cent of five-year-olds likewise. And in 1986 the South West Regional Dental Adviser recommended no action on fluoridation until it could be ascertained why, in this non-fluoridated region, there is less caries than anywhere else in England.[42]

An increase in chronic renal failure among young children, especially in fluoridated Birmingham, matches a report from Victoria, in Australia, which is now the most fluoridated country in the world. It says that the incidence of renal failure in children there is now so high that a child kidney transplant and dialysis unit has had to be established. A report of the Australian Kidney Foundation in 1982 indicated a 63 per cent increase in renal failure since 1977 — the date fluoridation was introduced to Victoria! If this is not enough, reports of harm caused by the use of fluoride toothpastes — mouth ulcers, stomach and

bowel disorders, cramps and diarrhoea — are not exactly denied in the pro-fluoridation British Dental Health Foundation's publication, *Facts on Fluoride*, which admitted that fluoride toothpaste should not be swallowed in large quantities because of its toxicity![43] In addition, Holland, Sweden and Chile all banned fluoridation during the 1970s on the grounds of its harmful effects on children. The case for fluoride, to put it mildly, remains unproven.

In its leaflet *The Primary Question Of Principle*, the National Pure Water Association suggests that the issue is not medical or dental at all, but 'a question of morals and policy'. It continues: '. . . fluoridation infringes a fundamental human right which, in a free society, should be inalienable (viz.: the right to decide, for ourselves, what substances intended to affect the development of our bodies shall go into our bodies).' Mrs Thatcher wouldn't disagree with that, would she?

One final point. The gas, hydrogen fluoride, is up to 1,000 times more toxic than sulphur dioxide, which to date is considered the chief mischief-maker in acid rain. 'Airborne fluorides have caused more worldwide damage to domestic animals than any other air pollutant,' stated the US Department of Agriculture in 1970.[44]

But that's for a later chapter. To be frank, I've had enough of this one. In my foolish youth I thought that those elected to rule over us were the best and bravest. Sick transit gloria mundi.

8
LEAD PIPES AND LAND USE

By now you may wonder if you'll ever dare face a glass of tap water again. But let's keep it in proportion. You're more likely to die on the roads, or of apoplexy over the poll tax, than by drinking water. At least in the short term. As the director of a firm selling domestic water conditioners wrote to me recently: 'Most people seem to want reassurance that their water supply is alright and, of course, this we quickly give them — there are very, very few authority supplies that do not basically conform to the EEC and WHO guidelines.'[1]

Yet this issue cannot be taken in isolation. If water quality begins to fail in societies with the wealth and capacity to ensure otherwise, the failure is primarily political and moral. The horror-story of fluoridation highlights this. Much of this chapter drives the point home. It's bad enough that water can deliberately be dosed with rubbish like fluoride, but when we face the ever-growing list of toxins dumped in water due to apathy, inefficiency or greed, it begins to look as if collectively we suffer from a death wish. Damage to the ozone layer, felling of the rainforests; not even Faust could have done better in the self-damnation line. So what now that we begin to realise we can't go on like this? Can we change? As economic, habitual and emotional investment in the ecologically murderous industries guaranteeing us our supermarket binge is so huge and entrenched, it seems as if, rulers and ruled alike, we've already decided to eat, drink and be merry, and tomorrow be damned. Entire nations remain apparently the willing hostages of giant multinationals to whom the bottom line is the balance sheet. These companies do much as they please. We let them. They can even get us to poison ourselves and call it progress.

As said earlier, the Robens Institute at Surrey University, studying tap water in the United Kingdom, has found over 300

chemicals in it that aren't there for our own good. These include pesticides, herbicides, industrial solvents, and the contaminants detailed below, as well as traces of man-made steroids such as contraceptive pills and drugs like Valium, Mogadon, and aspirin. These are found mainly in London and the south-east, where 20 per cent of the tap water is currently estimated to consist of sewage effluents.[2]

What are the major toxins in British tap water? Let's start with the EEC standards. Maximum admissible concentrations have been set in Europe for 37 factors or elements in public water supplies. The aim is to uphold health and sanity in EEC populations. In Britain certain areas exceed the limits for five of these factors: nitrates, lead, aluminium, trihalomethanes (THMs), and nitrites. We have looked at aluminium, and the THMs resulting from chlorine reaction with debris in water during treatment processes. Nitrites may also be formed by inadequate treatment. Nitrate and other forms of agricultural pollution constitute a major, growing problem. In 1986, 52 areas (most in East Anglia and the Midlands) exceeded the permitted maximum of 50 mg of nitrate per litre of mains water. Some US scientists want the permissible level reduced to 10 mg; in some UK regions the level has climbed as high as 150 mg. Nitrates enter water due to fertiliser run-off from farms, which are also implicated in pollution caused by slurry, silage liquor, and various pesticides.

But before dealing with these issues of land use and abuse, it's time to tackle another major problem; one which should no longer exist — lead.

LEAD

Lead poisoning has scourged civilisation since the time of the Romans. It causes lower intelligence, muscle and heart weakness, impotence, exhaustion, infertility, miscarriage and stillbirth, premature senility and death. Amounts required to cause damage are minute. Foetuses and infants are in especial danger, absorbing lead faster than adults due to their greater growth rate. Pregnant women drinking lead-high water risk bearing brain-damaged children.

Leaded petrol is the main cause of lead poisoning. Up to 90 per cent of atmospheric lead comes from cars: it is estimated that in 1987 some 3,000 tons were pumped into the air. In

central London, daily lead levels exceed World Health Organisation limits six months of the year. The M25 ringroad, which in 1988 carried 137,000 vehicles a day, has been described as an invisible wall of lead circling the city. Once in the air, lead may travel up to a mile either side of a motorway before falling.[3] If you live nearby, you risk accumulating lead levels that'll make you stupid before they kill you.

But here we are concerned with lead ingestion via water: a crisis in itself. Up to ten million people in the UK still receive drinking water at least in part through old lead pipes that are dissolving fast. The softer your water, the more acidic it is, and the more lead it dissolves. This is one reason for liming water: to raise the pH and reduce the risk of acid corrosion. When alum flooded the mains system during the Camelford tragedy it stripped huge amounts of lead from domestic pipes, in a region already prone to water-borne lead poisoning.

The worst-affected region in the UK is probably Scotland, due to soft water at source and wide use of lead pipes and storage tanks. Friends of the Earth (Scotland) claims that a third of a million Scots — about one in 15 — regularly drink water containing lead levels above EEC limits.[4] Grampian Region's Water Services Department estimates that about 50 per cent of all households it serves receive supplies through domestic lead piping;[5] in some areas of the Central Region the figure is about 40 per cent.[6]

The problem is acute in Edinburgh and Glasgow. An Edinburgh University team investigating lead's effects on 500 local children over two years have found that, even with lead intake under the current EEC limit of 100 micrograms per litre of drinking water, learning ability is measurably damaged. As a result of this research, specialists in the Scottish Office and the Department of the Environment have urged reduction of the current EEC limit from 100 to 20 mcg. Government statistics show that this limit, introduced in 1985 and accepted by Britain, is breached by 85 Scottish water supplies. In a letter to the *Scotsman*, Friends of the Earth (Scotland) Co-ordinator Ms Xanthe Jay said surveys of those at risk relied on *averages* of water samples over large areas, in compliance with a 1982 government circular. But the EEC directive requires *every* sample to be under the agreed limit, which both the Department of the Environment and the Scottish Office's own advisers consider *five times* too high. Applying this interpretation would more

than double the number of people defined as at risk, particularly in Edinburgh. 'The dispute about such technicalities has enormous financial implications,' Ms Jay's letter continues. 'If the new definition were applied it could cost the Government £5–6 billion to enforce.'[7]

In this case at least it seems the government may give in without objection and delay, having already informed water authorities that each and every sample must conform with the EEC limit. However, Whitehall is not moving fast enough for Brussels. The EEC is starting legal action against the British government in April 1989 on this issue, ordering Britain to correct the situation on pain of being taken to the European Court. 'Almost the only water in Scotland that is up to standard is in the Western Isles,' says a senior EEC official.[8] In Glasgow, where over 130,000 houses still use lead fittings, lead levels five times the current EEC limit, and 25 times the newly recommended safe level, have been found, despite the city policy of liming its water. 'We're a lead-damaged nation', claims Dr Michael Moore of Glasgow University. 'We have generations of people who are not achieving, and will not achieve, their full potential because of lead pollution.'[9]

Some 'experts' continue to deny the problem. One might ask if their denial arises out of lead damage to a more subtle organ — the conscience. Technically the solution is relatively simple — replace the lead piping with copper or unplasticised PVC. Yet as usual, we run into cash problems. Currently most water authorities and services offer free lead analysis. If the level is too high, free replacement of the communication pipe (from the main to the house) is made — but only if the consumer pays to replace the service pipes in the house. Grants are available for replacement — but replacement cannot be carried out if individual householders are apathetic or sceptical about the danger.

Again the problem is one of definition. Years of lead poisoning can't help people to develop the sense to see how much invisible harm lead has done and is doing to them. An official of a Scottish water service said to me that one solution may lie in increased powers for Environmental Health Departments to serve notice on householders that their property will be declared unfit for human habitation if they refuse to replace lead piping. This approach, by making resale of such properties impossible, could even work, though it begs the question of our wider political and social responsibility to eliminate this scourge,

and also relies on financial coercion of the individual. But so long as some politicians deny the existence of such an entity as 'society', social solutions remain beyond the pale. It seems the only answer lies in the individual's cheque-book. No solution is suggested for those so lead-damaged as never to have gained a cheque-book.

Meanwhile one wonders how many people conscientiously adopt lead-free petrol while still receiving water via pipes that guarantee them regular lead cocktails. A lead-free Porsche doth not a lead-free spirit make.

AGRICULTURAL POLLUTION

The attitude of the British government seems equally lackadaisical towards farmers whose high-intensive chemical input, pesticide use, and inefficient slurry and silage management has led in the last few years to the fastest-growing form of water pollution in Britain.

Silage and Slurry

In 1987, 3,890 cases of water pollution by farmers were reported in England and Wales.[10] Of these, 1,003 involved leakage of silage from stores, slurry tanks, lagoons and cattle yards serviced by out-of-date facilities.

The slurry problem arises mainly from the intensive farming of cattle and pigs. A generation ago, cattle wintered outside and their slurry fell on the land as natural fertiliser. Now they are penned inside. The slurry is scraped from the floor of their byres or sheds and put in 'lagoons' which can hold literally millions of gallons of faeces and urine, later to be spread on the fields. All too often such lagoons are inadequately made, left open to the elements, or sited close to ditch, stream or river so that, whenever it rains, the risk of leakage or overflow and subsequent pollution is considerable.

Silage liquor is even more toxic — 200 times more potent than untreated sewage. 40 per cent of all pollution cases involving silage result from keeping grass in leaking containers. Another 40 per cent arise from inadequate facilities for storing the green liquid that leaks out, liquid so strong it can eat into concrete. When it leaks into fresh water courses, the micro-organisms that feed on it rapidly deoxygenate the water, killing fish and every other higher life-form. In 1988 more than 3,000 fish died when

one farmer's silage effluent leaked into Colton Beck near Kendal in Cumbria.[11]

Of 225 prosecutions brought against farmers in 1978, 43 per cent of cases dealt with slurry or silage pollution. This represented a 76 per cent increase in court cases in one year. The maximum legal fine is £2,000 though average fines ranged from £141 in the South-West to £630 in East Anglia. One Somerset cattle farmer, fined £4,000 for three offences in 1987, recently told *The Sunday Times*: 'Look, it's cheap money. When you have a problem that could take £200,000 to solve, a £2,000 fine is nothing.'[12] Meanwhile, agricultural pollution incidents rose in 1988 to over 4,000. The number of prosecutions brought dropped to under 200.

'This is a problem that will not go away,' said Mr David Naish, Deputy President of the NFU in 1988, thus demonstrating more realism than the government which, applying the Ridley/Nelson blind-eye-to-telescope technique, apparently still believes that it will.[13] 'We have no wish to impose restrictions on farmers if the trend can be reversed through voluntary action,' stated Lord Belstead in 1987.[14] Two years on, the trend is not being reversed through voluntary action, and so far the government has kept remarkably quiet on the subject of imposing restrictions.

Some water authorities, rather than use the big stick (which in any case they seem to have mislaid), are trying the carrot. In 1987 one of the largest authorities, Severn/Trent, offered an award to farmers making the greatest contribution to preventing pollution.[15] Better than nothing.

Meanwhile the dimensions of the problem continue to expand. In Cumbria, new bacterial tracer methods developed by North West Water underline its seriousness. Until lately it was thought farms in limestone areas avoided pollution problems, as limestone soaks up toxins like silage effluent and sheep dip before they reach water courses. The new tracers show how toxins can often pour straight down hidden cracks under the soil to underground streams which travel for miles before coming to the surface. 'From now on farmers on limestone soils have to install collecting tanks, and it will no longer be permissible to make a silage clamp straight onto the soil — it will have to have a concrete base and sides,' said a North West Water spokesman in 1988.[16]

This illustrates the danger of making assumptions about the

safety of *any* agricultural or industrial practice where water is concerned. And not only where direct seepage is involved. There is evidence that farm slurry, by releasing ammonia into the air, adds directly to the problem of acid rain. One solution to this menace lies in a new technique of injecting slurry under the soil, rather than spreading it on the surface. This reduces the amount of ammonia released into the air. It also means less nitrogen is left in the soil to contribute to plant growth, but this is certainly the lesser evil.[17]

Nitrates

Many groundwaters naturally hold small amounts of nitrate nitrogen. Concentrations range from 0.1 ppm to 3–4 ppm in most areas. In their natural concentration nitrates present few dangers. But in their current accelerated use as agricultural fertiliser they present what has been described as 'the biggest environmental time bomb in Europe'.[18]

Why? Because growing crops do not take up all of the nitrates added to them. Surveys in the United States indicate that up to 64 per cent of nitrogen added by farmers to their cereal fields is rejected by the crops, ending up in groundwater, which ends up, via ditch, stream, river and reservoir, in your tap water. With what result? Biologist Philip E. Hartman claims there is a 'significant, widespread association between nitrate intake and gastric cancer mortality'.[19] This claim is supported by researches carried out in Denmark,[20] while Australian research associates the drinking of high-nitrate water during pregnancy with increased risk of birth defect.[21] Adults, especially the elderly, may suffer headaches, nausea, and general fatigue due to the presence of nitrates in the water they drink.

Yet young children are most at risk from this chemical run-off into water from the high-intensive farming that provides us with our breakfast cereal. Some scientists claim that nitrates threaten infant health, causing methimoglobinemia, or 'blue baby syndrome'. Though less than lethal in themselves, nitrates when eaten can be reduced to nitrites in the infant intestinal tract, subsequently binding to haemoglobin in the blood stream in preference to oxygen, resulting in oxygen starvation and possible death or brain damage. Water authorities in areas of Yorkshire got worried enough to issue bottled water for babies when nitrate levels got too high; in East Anglia an emergency bottling plant was set up to do likewise.[22]

Lately Mr Ridley opposed Department of Agriculture plans to compensate farmers for not polluting drinking water with nitrate fertilisers, though he has given in to EEC threats of prosecution, to reduce nitrate levels in the water supplies of 900,000 people in the Midlands and East Anglia. Proposed 'Nitrate Protection Zones' under consideration by a Cabinet sub-committee could end farming of around 400,000 acres, and impose low-intensity, nitrate-free farming on up to a million acres. The compensation to farmers could run into billions — if the sub-committee ever reaches a verdict. Mr Ridley says 'the polluter pays'; Agriculture Minister Mr Macgregor (lately egged into exhaustion by salmonella problems) says it's impossible to identify the polluter when the nitrates may have been trickling down into the aquifer for forty years.[23] Mr Macgregor may be right, though perhaps (with the farming community breathing down his neck) for the wrong reasons. Mr Ridley no doubt knows that insisting that 'the polluter pays' will delay reckoning to a future date when neither he nor his colleagues will have to face the music.

Because of the slow percolation of rainwater through unbroken rock, nitrates applied today will not appear in groundwater for many years. The present crisis in densely farmed areas like East Anglia and the Midlands results from much lower levels of nitrate application years ago. God knows — the government certainly doesn't — what level of nitrate pollution will be found in mains supplies in these regions in twenty years as the result of present levels of fertiliser application.

Gulp! Or maybe you'd better not. Meanwhile, statistics from Mr Ridley's department show that the number of groundwater sources severely polluted by nitrates more than doubled between 1970 and 1986, while the number of UK citizens receiving drinking water with nitrate levels over EEC limits also doubled in one year (1985-86).[24] The government (aka Mr Ridley) has not shown overdue signs of concern.

What can you do about it? Distillation, boiling water and condensing the steam onto a metal coil in another tank removes 99 per cent of nitrates. But take care: simply boiling water concentrates nitrates. Another way is to take plenty of Vitamin C, which detoxifies nitrates and nitrites, and prevents nitrates converting to nitrites in the digestive tract.

Pesticides

And here we go again. A survey of pesticide levels in drinking water in England and Wales, carried out between July 1985 and June 1987 by Friends of the Earth, shows that the Maximum Admissible Concentration (MAC) for any one pesticide (0.1 ug/l = 1 part per billion), as specified by the EEC Drinking Water Directive (of which the United Kingdom is a signatory), was exceeded in 298 water sources and supplies. 16 different pesticides were involved, the most common being Atrazine and Simazine — widely used as 'total weed-killers'. These were regularly measured above the MAC throughout several regions: Anglian (with the highest overall concentration), North West, Severn-Trent, Thames (where the Mid-Southern Water Company measured Atrazine at 45 times the legal limit), Wessex and Yorkshire. Lack of evidence from other regions, the report suggests, 'may reflect upon inadequate investigations by water suppliers'.[25]

At their 1988 Brighton Crop Protection Conference agrochemical experts insisted their business has 'no case to answer' on environmental pollution. ICI Agrochemicals Research and Development director John Finney quoted Anglian Water's belief that such chemicals are more likely to leach from railway or council-owned land than farms. He said that UK farmers have cut agrochemical application levels over the last five years, and that the decline will continue. Tony Pike, director-in-charge at Schering Agrochemicals, declared he was 'happy to sample any UK water' — meaning, presumably, to drink it — and insisted: 'You do have to separate pollution through misuse or abuse for which the polluter should pay.'[26]

Do you? Why? Whatever the cause, pollution affects all of us, even executives fighting their industry's corner by blaming someone else. Yet by insisting that 'the polluter should pay', Mr Pike (if in nothing else) agrees with Friends of the Earth, and with Mr Ridley too. Convenience makes for odd bedfellows!

Meanwhile the British government is pressing the EEC for an amendment to the Drinking Water Directive, replacing the MACs with limits for individual pesticides 'which are more closely related to health risks'. What sort of health risks? A health risk to UK citizens — or to someone's pocket? Again we're in an area where one man's proof is another's public relations. About all we can say is that the cost of cleaning up pesticide pollution and replacing existing chemicals with 'safer'

products will be huge. For a start, there is no reliable information on pesticide water pollution. Successive governments approved pesticides without proper research, either into leaching rates through different types of soil, or into possible health risks due to chronic exposure even to low levels of these chemicals.

Thus in late 1986 a senior Ministry of Agriculture official said that, for safety studies on older pesticides: '. . . there may well be considerable deficiencies in terms of today's standards'. He added that safety reviews for all pesticides now used in the UK 'could take twenty years', and that companies selling chemicals approved up to 20 years ago 'will be asked to produce the additional data necessary to justify continued sales'.[27]

But why is the sale of older pesticides (some 150 of them) allowed at all if additional information is required? Demanding suspension of their use, Friends of the Earth insists that the burden of proof of safety should fall on the companies, not on the public and the environment.[28] An ICI spokesman has conceded that 'even following strict adherence to good agricultural practices, the continual use of certain pesticides under certain "adverse" conditions might ultimately cause some low level contamination of groundwater'.[29] And Brian Croll of Anglian Water, one of the worst affected regions, states that the pesticide: '2,4–D, which has a persistence in soil of only a few days, has been recorded as undergoing no degradation in stream water after six months'.[30] Which is not encouraging, since recent epidemiological studies suggest that occupational exposure to chlorophenoxy herbicides, like 2,4–D, can cause certain rare cancers in humans.[31]

Equal cause for concern arises from the use, sometimes illicit, of organochlorine pesticides as sheep-dip. Dieldrin, banned in most of the rest of the world for years, may be the most pernicious of these. Still legally used in Britain in wood preservatives, once dieldrin enters water it can have a disastrous effect on fish-life and all who feed on those fish — otters, heron, and man. A persistent bio-accumulator, its toxicity increases the higher it moves up the food-chain. It does not degrade; it remains in the environment. Eels, due to high fat content, are especially dangerous as a food source if present in dieldrin-contaminated water, such as the River Lossie in North Scotland, the River Mole in Devon, and the River Frome in Gloucestershire. So are bottom-feeders like flounders.[32] Another

chemical used in sheep-dip, Dichlorphenthion, is implicated in causing cot-deaths in the sheep-farming areas of Northumberland, Cumbria, Cornwall and North Wales. The Medical Research Council is considering investigation of this link, given the possibility that dip chemicals may be entering the water via flash floods and heavy rainfall. Dr Lewis Routledge, a Newcastle biochemist whose eight-year-old son is semi-paralysed and cannot speak after touching a chemical dip, says that, before they die, cot death victims shows the same signs of gasping and breathlessness that his son suffers. However the Ministry of Agriculture says that such chemicals are rendered harmless by soil-bacteria if disposed of correctly by mixing with slurry and spread over land.[33] In short, nobody knows how badly drinking water may be contaminated by pesticides, nor exactly what harm such contamination may do to us.

In August 1987, the EEC having begun proceedings against the British government for ignoring the Drinking Water Directive, EC Environment Commissioner Stanley Clinton Davis said that: 'It is a disgrace that Member States should fail to respect the laws which they have themselves adopted. Water quality is a matter of wide public concern and we have an obligation to see that the law is respected.'[34]

So who's to blame? Farmers? For forty years they've been encouraged to use these chemicals. For forty years they've slapped the stuff onto the land, or lashed hormones into cattle. Meanwhile the rest of us cruise into the supermarket to buy the polythene-packed slaughterhouse or test-tube results. No one group is to blame. This is a problem we all have to face.

9
INDUSTRIAL DISASTERS

Now for a sluggish swim through the muck our industries pour into river, sea, and sky. But nobody should imagine that Britain is an island unto itself in these matters, or even invariably the worst offender. In certain areas of ecological disaster Britain isn't even in the same league as some other countries. So, before taking our own industrial hooligans to task, let's make a brief tour of ecological excess elsewhere. After all, an essential aspect of this entire issue is that it is international. Water gets everywhere; nobody pollutes themselves alone. And the philosophy of material growth — literally, it seems, at all costs — appertains throughout the increasingly industrialised globe. We are all at risk from one another.

WATER MISUSE INTERNATIONAL

Over half the North Sea's pollution comes from the Rhine. Mercury, cadmium, farm run-off, urban sewage, and acid-ruined forests on its banks make it Europe's sickest river, worse even than the Mersey. Britain's football hooligans may be No. 1 when it comes to terrace mayhem, but on 1 November 1986 the Swiss hit the top of the River Pollution Charts when about 30 tonnes of mercury and other hazardous chemicals including PCBs (polychlorinated biphenols) were washed into the Rhine after a fire at the Sandoz factory at Basle. A second leak on 7 November poured 50,000 litres of chemically polluted effluent into the suffering river. Hundreds of thousands of fish died.[1] Two weeks later, two discharges totalling 2,000 kg of weedkillers entered the Rhine after an accident at the BASF Chemical Company at Ludwigshafen, West Germany.[2] Much of this poison ended up in the North Sea; we still trustingly eat from its declining numbers of fish when presented to us on ice at the

supermarket slab. It was at Sandoz in the early 1940s that chemist Albert Hoffman first synthesised lysergic acid diethylamide, LSD25. Is it coincidence that research producing LSD (a short-cut to fake nirvana) also leads to other kinds of scientific short-cuts, like short-cuts to biological extinction?

The United States can claim the first classification of a river as a fire hazard. In July 1969 oil floating on the River Cuyahoga flowing into Lake Erie combined with gases released by sewage effluent on the river bed. The Cuyahoga caught fire, nearly burning down two bridges! North America is also ahead when it comes to over-abstraction. In 1988 the grain belt of the Midwest was struck by drought. A worse crisis may soon hit that vast region due to years of over-abstraction from the huge aquifer underlying much of it. Estimates suggest as much as two-thirds of the available water may have been used up. Parts of Southern California are similarly threatened. Seventy years of demand for giant tomatoes and swimming-pools in what is essentially desert have lowered the water table from an average 20 feet to 120 feet below ground level. This drying-up also increases the risk of earthquakes. The shortage is such that in the early 1980s a State Proposition to build the 'Peripheral Canal', diverting the waters of the Sacramento and other northern rivers to the south, was narrowly defeated. Perhaps the risk of turning San Franscisco Bay, by which five million people live, into a vast mud-sink made people think again. Meanwhile, Mono Lake in the Sierra Nevada has been so abused that now it is little more than a salt-flat.

The Soviet government has done even better. 35 million years old, the landlocked Aral Sea lies north of Iran. Until lately it covered an area the size of Eire. In just two decades it has become a disaster zone, thanks to the policies of the Brezhnev era. Towns that were once fishing ports are now stranded *50 miles* from the sea. And due to the poison dust now whipped up by the storm winds that ravage the region, infant mortality has risen to over 71 per 1,000. In some areas, the infant death rate is over 100 per 1,000.

How was this great economic and social advance achieved? By the plantation of thirsty cotton, and through irrigation projects designed by geniuses, so well designed that most of the water evaporated, reducing the sea's volume by a third in far less than a lifetime, leaving huge areas of desert rich in poisonous agrochemicals to be washed into declining rivers by supremely efficient drainage. The masterstroke was the over-

use of herbicides and pesticides long banned in the inefficient West. The United States uses only 1 kg of chemicals per hectare; in the USSR as a whole, 2 kg are used, but in the Aral region every hectare is drenched with 52 kg of death-enhancement! Worse still, climatologists believe that this shift in regional ecology has been so effective that even the Indian subcontinent might soon be affected by changed weather and rainfall patterns.[3]

Interestingly, this disaster has led to the first public lampoon of a member of the Soviet government in Gorbachev's new USSR, on the cover of a recent issue of the satirical magazine *Krokodil*. The victim? Nikolai Vasilyev, the Minister of Land Reclamation and Water Resources.[4]

But maybe the worst continuing ecological disaster of all (not forgetting the ozone layer) is the wilful destruction of the Amazon rain forest with its flora, fauna, and human population. At present rates of felling, no forest will be left in 30 years. In 1988 an area the size of Belgium went up in flames. This is being done to create cattle-land — and hamburgers. The grazing lasts a few years. After that: desert. One of the world's lungs is being ripped out and it seems nobody can stop it. Those responsible commit crime on a scale unparalleled. Not only do they murder thousands of people, they threaten the life of the planet itself.

But apparently flirtation with extinction is respectable. Take the nuclear industry. Where that's concerned, Britain is well up the charts.

NUCLEAR POLLUTION

The Chernobyl disaster of 26 April 1986 poisoned much of northern Europe with radioactive rain. From Norway to Eire livestock suffered. Entire herds of reindeer had to be destroyed, as did flocks of sheep in upland Britain. The highest levels of fallout in the waters round the British Isles were measured over the Irish Sea. The radionuclide concentration in marine fish was also highest in the Irish Sea; radioactivity in sediment in neighbouring coastal areas peaked at several thousand becquerels per litre in early May.[5] The disaster is not over yet. Indeed, it is impossible to tell how the effects of such a catastrophe will linger in terms of soil poisoned by the hard rain that fell, and in terms of cancers yet to appear.

Have we learned any lessons from Chernobyl? It doesn't seem so. After all, it's only 30 years since much of Europe was drenched by a radiation blow-out from Windscale, alias Sellafield. Being modest, we failed to claim or even admit to this, even to our own citizens. Nor now do we publicise our pollution of the Irish Sea with 2.2 million gallons of Sellafield's low-grade nuclear waste every day, or advertise our importation of spent nuclear fuel from other lands, fuel carried for reprocessing on midnight trains through densely populated areas from the south to the north of the country.

Now, with electricity privatisation to follow that of water, the government plans to protect the nuclear industry from free competition. Why? Because nobody wants to invest in nuclear power. This is not just because it's dangerous, but because it's economically inefficient. That's why no new reactors have been commissioned in the USA since the near melt-down of Three Mile Island eleven years ago — which doesn't stop companies like Westinghouse selling their technology in other countries, like the United Kingdom.

US armed forces in Britain, being modest, have not advertised how several of their Scottish-based nuclear submarines have knowingly dumped radioactive coolant into the River Clyde on various recent occasions.[6] Nor were they quick to report the grounding in the Irish Sea on 13 March 1986 of the *Nathanael Greene*, carrying 16 Poseidon ballistic missiles.[7] Only when a second US nuclear attack submarine, the *Atlanta*, went aground on 29 April 1986 in the Strait of Gibraltar did they acknowledge the event.

The Royal Navy has had similar problems. In November 1988 it admitted a leak of radioactive coolant into the naval dockyard basin at Rosyth on the Fife side of the River Forth, near Edinburgh. Here, Britain's four Polaris and 18 other nuclear submarines are refitted; the Trident submarine is to be refitted here by 1995. The Rosyth Public Safety Scheme (ROSPUBSAFE) says that an area of a 550 mile radius round a submarine should be evacuated as soon as a reactor accident happens. In January 1989 the Royal Navy claimed that the chance of an accident involving the 50,000 people of Dunfermline and thousands of others living even closer is 'extremely remote'. Perhaps this is why at no point does ROSPUBSAFE actually detail any evacuation plan for local people in the event of such an accident.[8] It is heartwarming to know that our armed forces care.

So people close to the Forth, the Clyde, and the Irish Sea have the pleasure of knowing that radioactive waste enriches their waterways, and may also be pleased to know that another embarrassment soon to confront the Royal Navy is how to get rid of the reactors from old nuclear submarines. The brightest idea so far is to dump them deep at sea.

But radioactivity can enter water from other sources. In 1983 it was discovered that the thyroids of animals and people in and about Weybridge, Surrey, contained levels of the isotope iodine-125 up to *twice* those found in animals grazing near Sellafield and other nuclear plants. A team led by Dr Colin Bowlt traced the contamination to drinking water from the Thames, where swans living on the river were similarly affected. The source was thought to be local research establishments and hospitals that flushed such waste away into the sewers. The first findings were reported to the Department of the Environment in October 1983 . . . yet no contract for the full study reached Dr Bowlt until early 1986. When it came, he saw the work was to be covered by the Official Secrets Act. Told after protest that he could make his findings public, he signed. A year later he had still not received the go-ahead from the Department of the Environment, and was faced with having to abort the project.[9]

The modesty of HM government in publicising such matters is notable. The same is true of some UK companies who are making an heroic all-out effort to degrade the environment. Consider the following triumphs.

LANDFILL — DISPOSAL OF HAZARDOUS WASTES

Britain is now a net importer of not only nuclear but also other deadly wastes for 'treatment'. Since 1985 the amount of toxic waste landed in our small, overcrowded isle has grown from 5,000 to 53,000 tons a year. Some 5,000 tips are in use. 2,000 are closed. About 800 old dumps are close to housing.[10] Many of these tips contain poisons that nobody else in the world wants. Regulation is poor or non-existent. The chemicals are rarely identified before being dumped into holes in the ground. This goes on with the blessing of the Mother of Parliaments.

No wonder that, in August 1988, the captain of the *Karin B* thought he could dock in the United Kingdom to land his load of 2,100 tons of hazardous waste originating in Italy (which can treat less than a quarter of its own hazardous waste) and

later dumped in Nigeria. Nigerian dockers at the port of Koko fell sick on handling the leaking drums. But they counted no more than the people of Brownhills in the West Midlands living near the huge disposal plant owned by Leigh Interests (Britain's biggest dealer in such waste, with 20 sites round the country). So the *Karin B* came to Britain, hoping for a contract with Leigh, or with other UK waste disposal companies interested in this lucrative cargo.

But residents of Woodbridge housing estate by the site were enraged by news of the cargo's approach. Asthma, bronchitis, and nausea have plagued them for years. The *Karin B* was the last straw. 'We are scared of what they are putting down the holes,' said 14-year-old asthma sufferer Sarah Brown, interviewed by *The Observer* during the resulting angry confrontation at Leigh's gates, 'Some of the men have got nasty with us.'[11] What else? It's a nasty business.

The *Karin B*'s load was to have been just one more such quietly landed and buried in Britain. Ripe pickings for waste companies, the threat of sickness for everyone else. But the *Karin B* was different. The public outcry raised by Friends of the Earth at the ship's approach meant even Whitehall couldn't ignore it. By 23 September the *Karin B*, rejected by Britain and everyone else, was at Livorno in Italy, back where the waste came from. The Italian government, under international pressure, ordered either Livorno or Ravenna to accept it. Both refused. Crew had to be hospitalised before Livorno would accept the cargo — on the proviso that a disposal site other than Livorno would eventually be chosen.[12]

What's the matter with us in Britain? Why must mothers have to push babies up against company barricades before our government is shamed into rejecting what should never be accepted in the first place? The 'industry' *is* a scandal, not so much because it exists (we have to annul, defuse, or otherwise get rid of such poisons somehow, at least when they originate in Britain), but because the disposal regulations are not only criminally lax but, to date, almost completely ignored by all concerned.

It is 15 years since local authorities were required to provide plans for dealing with waste. By 1988 only 23 of England's 75 local authorities had complied. They are obliged to licence any applicant, if the site has planning permission and can be operated without risking public health or polluting water. No qualif-

ications are needed. Previous incompetence or malpractice is not taken into account. Until 1988 the Hazardous Waste Inspectorate had just six men to supervise 5,000 sites. That number has now been increased to 18.[13] 85 per cent of site licences inspected in 1986 were found to have broken the law by failing to make operators record where they put the most dangerous wastes. Only three sites had facilities to test the wastes they received to learn what they were handling and no offenders have been prosecuted. 'It is an unlucky malefactor whose sins find him out,' said an inspectorate spokesman at the time of the *Karin B.* 'Illicit loads will only be discovered when the landfill erupts in brown fumes . . .'. Mr Edward Wilkinson, a Leigh director, calls the situation 'chaotic'. Sir Richard Southwood, former chairman of the Royal Commission on Environmental Pollution, describes the 'controls' as 'ramshackle and antediluvian'.[14]

But there are signs of progress. In March 1989 the Conservative-controlled Environment Select Committee unanimously condemned Mr Ridley and his Environment Department for lack of leadership, commitment, and control over toxic waste, and expressed 'incomprehension' at Mr Ridley's failure to monitor such waste. According to committee chairman Sir Hugh Rossi, it is 'little short of a miracle that we have not had disasters from the escape of poisons into our water supplies or from gas explosions'.[15]

Rossi recommends tougher controls for England and Wales. Meanwhile in Scotland pollution controls are 'a complete shambles' says Friends of the Earth's Scottish co-ordinator Xanthe Jay. She wants the Scottish Office to adopt Rossi's proposals, and adds 'with England in the spotlight, the obvious place for cowboy contractors to look for a hole in the ground is north of the border'.[16]

INDUSTRIAL DUMPING AND SPILLAGE

What wastes are involved? When the *Herald of Free Enterprise* sank in 1987 it was carrying six drums of cyanide and 25 of toluene di-isocynate, all bound for Britain.[17] Fancy a morning cuppa cyanide, anyone? Or how about some TBTO or Lindane from your local river? At loose in this land are spoilers more dangerous than any soccer thug. Some of Britain's biggest firms stand exposed as habitual law-breakers, ignoring pollution controls to dump toxic waste into river or sea without fear of prosecution.

Many smaller firms are not much better.

MAJOR TOXIN LEAK THREAT TO WATER SUPPLY headlines an *Observer* tale for our times. In February 1989 150 gallons of two highly toxic chemicals used in wood preservatives, Lindane and tributyltin oxide (TBTO), leaked from a timber company's yard into the River Wey at Godalming in Surrey. Vandalism was suspected. Lindane can cause aplastic anaemia (an often fatal blood disorder attacking the liver), leukaemia, and convulsions in animals. Its domestic use is banned in the United States; a further 16 countries restrict its use. TBTO was lately banned for use in anti-fouling paints in the UK after the discovery that it makes dog whelks grow extra penises.

'The chemicals will seep into the soil and fish will die,' said Mr David Hayne, technical manager of a wood preservative company that banned these chemicals in 1986. 'Birds that eat the fish will also be affected.' This leak stretched four miles down the Wey, a tributary of the Thames. It was discovered by detectives looking into another leak, of 3,000 gallons of heating oil after tanks had been opened at an industrial estate.[18] A month later Patrick Nicholls, Undersecretary of State for Employment, rejected demands by Labour and Conservative backbenchers to ban Lindane and Pentachlorophenol, claiming that most of the allegations about them were anecdotal and on examination had proved groundless.[19]

12 days after Mr Nicholls made his statement the Indonesian cargo ship *Perintis* sank off Guernsey during a heavy storm. A container of Lindane and other chemicals went down with it, immediately triggering a frantic search from both sides of the Channel. British, French and Channel Islands emergency services were joined by a French minehunter and mini-submarines. Dr Paul Johnston, a Greenpeace research fellow at St Mary's College, London, warned that if the six tons of Lindane spilled, they would contaminate 1.5 billion tons of sea water; Greenpeace said that the Channel faced disaster on an unprecedented scale if the chemicals weren't recovered quickly. Even the British government said that widespread damage to sea life and the fishing industry could be caused if the Lindane wasn't recovered quickly.[20] But if the allegations against Lindane are anecdotal and groundless, how can this be? Again we see alarming discrepancy between complacent official statements and what actually happens when a ship carrying such a poison goes down. Minehunters and mini-submarines? What is going on?

Whatever it is, it goes on everywhere in Britain.

The River Lossie is a quiet stream winding north to the Moray Firth, well loved by anglers who fish it for flounder, eel, finnock and brown trout. But in February 1983, 2,500 gallons of Protim wood preservative were spilled at Elgin City Sawmills (ECS). Protim then contained Pentachlorophenol, TBTO, and Dieldrin. The spill leached into the Tyock Burn, thence into the Lossie. A further spill occurred later the same year. ECS admitted neither incident until 1984 when the North East River Purification Board (NERPB), puzzled by the lack of invertebrate life in the Lossie, investigated and confronted them.

Elgin Anglers Association (EAA) had been wondering where all the fish had gone and asked ECS to contribute to a restocking programme. But ECS refused on cost grounds, in that NERPB had made them take steps to stop the pollution. These steps proved ineffective. Protim continued leaching into the Lossie. Dieldrin levels in Lossie eels in 1986, three years after the first incident, were the highest in Britain, at 1.2 mg per kg of flesh. The *maximum* safe level is given as 0.1 mg per kg. Many think this too high. Lossie eels were thus *12 times* the 'safety' level and so toxic that no more than 1¼ oz (under a mouthful) a week were thought safe to eat. *Yet no public health warning was issued*, even though English servicemen and their families at nearby RAF Lossiemouth habitually caught and ate these eels.

Meanwhile, even as the Dieldrin in Protim was replaced by Lindane (without consent), the EAA's attempt to sue ECS foundered in a swamp of delaying tactics and letters unanswered by ECS solicitors and insurers. Letters to the Department of Agriculture Food and Fisheries likewise went unanswered. By March 1989, with Dieldrin from the original spills still entering the water, and ECS still using Protim, and the NERPB still relying on persuasion rather than prosecution, EAA President Jim Tait offered his resignation for failing to gain satisfaction from the polluters (though since this time, ECS has agreed to stock the river with young trout, and make a financial contribution to the EAA, as a 'goodwill gesture'). Mr Tait expressed his shock at what he had learned since beginning to research the effect of such chemicals, and at recently learning that Lossie eels were *still* being eaten. 'My anger at the way we have been treated knows no bounds,' he told a packed meeting of members, who rejected his offer to resign. 'You don't change your leader in the middle of a battle,' said one of them.[21]

A battle? It's more like a war in which many individual battles are fought. It's worrying how few of us care until one day our favourite river or beach is ruined by criminal negligence at a factory or farm. Even more worrying is not only how such pollution often goes unpunished, but how easily the polluter can continue his foul, antisocial, deadly activity.

For incidents like this are minor compared with the routine, deliberate pollution of water by big businesses like ICI, British Coal, British Gas, British Leyland, British Petroleum, British Creameries, British Tissues, the CEGB, Coalite, Morphy-Richards, Rowntree-Mackintosh and Total Oil.[22] These household names appear on recent lists of pollution incidents recorded by RWAs, who are reluctant to prosecute such big fish (not least because their own sewage works accounted for 20 per cent of the 23,253 incidents of inland waterway pollution in England and Wales recorded in 1988). The total number of prosecutions was 288. Many were directed at farmers, responsible for 19 per cent of all recorded cases. 37 per cent were caused by dirty industries. The other 24 per cent remain unexplained.

These figures mean that rivers in the United Kingdom are being polluted at a faster rate than at any time since national records began in 1958. Analysis of RWA data by the *Sunday Times* Insight team shows how, in the last two years, 453 miles of river in England and Wales have been poisoned. Ten per cent of the 27,500 miles of river and estuary in England and Wales is now too filthy and deoxygenated to support fish. The worst decline is in the south-west; 230 miles of river having been downgraded since 1986.[23] This disaster results from government reluctance to impose the Control of Pollution Act 1974; from loopholes in the Act (many repeated in the current Water Bill); from relaxation of controls over permitted pollution levels; and from the reluctance of many magistrates, who hear pollution cases alongside speeding offences and other gross criminal acts like non-payment of TV licence fees, to impose punishments that really bite.

It results from a political bias that claims industrial growth and the making of profit therefrom to be sacrosanct. When did you last hear of a company chairman booed and hissed on his way to jail with a placard round his neck labelling him 'POLLUTER'?

Companies like British Coal (prosecuted 21 times in the last three years for serious pollution offences) and British Tissues

(whose bleach-pollution of the River Llynfi in Mid Glamorgan in 1988 killed an estimated 30,000 trout and salmon) find it cheaper to pay the derisory fines imposed on them than spend the much larger sums required to clean up their filth. Of those few companies actually charged and found guilty, many have received conditional discharges or fines totalling a few hundred pounds — a drop in the ocean. Recently a Humberside chemical firm was conditionally discharged after causing a spillage which dyed the River Hull blue. Such verdicts help to explain the reluctance of water authorities to prosecute.

'It is very high in manpower costs to prosecute and when you do get the firms to court, the fines are abysmally low,' a WAA spokeswoman told the *Sunday Times.* The authorities also complain that staff cutbacks of up to 25 per cent and spending cuts imposed over the last decade hamper their efforts. Perhaps too the increasing numbers of industrialists on the boards of water authorities has something to do with it; the 1983 Water Act allows the government to make direct appointments to such boards.

In Yorkshire, where a WA register lists 142 private firms and public companies breaching their discharge limits over the 12 months up to August 1988, some every time a sample was taken, British Steel's coking plant at Orgreave went 918 times over the limit in March 1988.[24] An effluent treatment plant has since been installed at Orgreave at a cost of £85,000. British Coal's profit in 1988 was £419 million.

28 of British Coal's Yorkshire colliery outlets broke their consents (permitted levels of discharge) 79 times between August 1987 and July 1988. In December 1988, BC's subsidiary, Coal Products, was fined £1,000 for discharging toxic coke liquor into the River Cynon in South Wales. In January 1989 it was fined £700 for discharging a lethal mix of phenols, thiocyanate, and ammoniacal nitrogen into the same river. £1,000, £700; will such fines really make them mend their ways?

One of the highest fines to date was imposed on Express Foods Group, which let 100 gallons of ammonia leak into the River Eden in Cumbria in 1987. For this Cain-like activity, which killed all animals and plants over a 5-mile stretch of the river, the company was fined £25,000. 'Pollution is totally unsatisfactory,' declares Express Foods Group chairman Michael Hodgkinson. Tell it to the Marines, Mr Hodgkinson!

Because in the United States (no mean polluter itself) the

penalties are stiffer: maximum fines of $25,000 *a day* for violation, and/or up to a year in prison. One year? Is that all? Environmental muggers should be so lucky!

Then there's ICI. WA samples indicate 40 separate cases in 1988 where this standard bearer of our national values failed to meet its consents. Though a three-fold reduction in pollution in one ICI factory on the Tees since 1970 has led to once-dead stretches of that river returning to life, elsewhere the record is poor. In 1988 its Rocksavage works on the Mersey released double the permitted levels of mercury; another ICI factory at Castner Kellner on the Mersey — one of Europe's dirtiest rivers — in 1988 also made a habit of breaching pollution limits.

These limits are hardly draconian. Norsochem, a giant chemicals plant on the north side of the Mersey estuary, is licensed to pump out each year over a tonne of cyanide, 33 tonnes of benzene and toluene, and 500 tonnes of ammonia. Just to make the cocktail more interesting?

As things stand, water companies foul water as they like, where they like, and devil take the rest of us. Their officials can pack the boards of water authorities, whether public or private (privatisation is, in this context, just a red herring) and get their way, even as companies continue to create real damage of a sort that must make any proud terrace hooligan green with envy. 'Green', did I say? The joke's on all of us. But it's a sick joke. Literally.

One cause of water authority reluctance to press pollution charges must be that quite often they too find themselves in the dock, usually over illegal levels of sewage discharge. Anglian Water has the worst record of any. Its own data reveal that 33 per cent of its sewage discharges are illegal.[25] An unpublished report on river quality and river sewage prepared by HM Inspectorate of Pollution says that dilapidation, overloading and manpower reductions are the main causes of sewage works failure in Anglian and other water areas.[26] 'You can't expect a water authority to crack down hard on industry if at the same time they're guilty,' points out Sir Hugh Rossi, the Conservative chairman of the Commons Select Committee on the Environment that recently slated Mr Nicholas Ridley for his poor efforts at hazardous waste control.[27] We can only hope that the creation of the National Rivers Authority, as proposed in the current Water Bill, will improve the situation by removing supervision of water quality and abstraction from the RWAs.

'We could not let a privatised company remain as the regulatory authority for pollution control, water quality, abstraction, discharge and the like, when such functions were clearly at odds with maximising its efficiency and profits,' explains Mr Ridley.[28] Bravo! If the NRA proves as zealous at prosecuting English and Welsh water authorities for illegal sewage discharges as the Scottish RPBs have proved to be in the last 15 years over taking regional councils to court for the same offence, the cost of the actions will be precisely zero.

But the NRA still lies in the future. It remains to see how effective it will be. Meanwhile, given that the official bodies dislike prosecuting other official or commercial bodies, it's left to the individual or small group, who usually can't afford either the money or the time involved in cutting through the red tape and legal obfuscation big companies can hire — as we saw in the case of the Elgin Anglers Association.

But now and then it happens. East Anglian mussel farmer John Lewis has issued a High Court writ against Anglian Water. The mussels of the Wash are so polluted by sewage he has to purify them for 14 days before they can be sold. Mr Lewis is determined that the polluter should pay.[29] In 1986 police inspector Malcolm Beavers waded into the River Aire in Yorkshire to save a man trying to drown himself. For this he was awarded a Royal Humane Society testimonial. He was also struck down by an illness eventually diagnosed as post-viral fatigue syndrome, caused by sewage-borne bacteria. Losing memory, strength, and concentration, he had to quit his job after a year's sick leave. Yorkshire Water Authority may be sued.[30]

Tony Wakefield founded the Coastal Anti-Pollution League after his daughter died after bathing in sea-borne sewage.[31] Since 1960 the League has published *The Golden List*, a guide to the quality of British beaches. That such quality is often execrable is perhaps due not only to raw sewage discharge but also to the activities of companies like British Coal, which daily dumps 320,000 gallons of dust and sludge — 800 tanker loads — into the North Sea off the Durham coast. Disposal of solid waste has been stopped by government action for once, but in 1988 the Northumbrian Water Authority told British Coal it could carry on sludge dumping for another four years. A study by marine biologist Dr Tony Nelson of Swansea University found only 18 specimens of plant and animal life on the shore by Seaham. Fishermen have to go three miles offshore to avoid the spread of

the waste, which pollutes by smothering the seabed. In September 1988 thousands of dead crabs were washed ashore. 'We have not had a lobster for five weeks,' said inshore fisherman Thomas Hulley, 'If this gets worse, we won't be able to make a living.'[32] Hopefully this won't prove to be an epitaph for the North Sea itself. It's time now to take a deeper swim. Hold your breath . . . and your nose.

10
THE NORTH SEA

7,000 years ago the North Sea didn't exist. Huge forests stretched from the Humber to the Elbe. Then the climate warmed, glaciers melted, and the low-lying forests flooded. A fertile sea was created, one which ever since has sustained a wealth of life — mackerel, plaice, herring and cod — which has supported North Sea fishermen and fed people for centuries. Now that wealth, and the North Sea itself, are threatened by human irresponsibility on a high scale.

Parts of the North Sea, especially off south-east England, are less than 50 metres deep. Its waters find no easy way out to the abyssal ocean beyond. To clean itself via the natural flushing motion of its currents would take at least three years even if we stopped dumping our rubbish in it today. You'd think we'd care for such an important body of water. Maybe we will, before it's too late.

For, though disaster is plainly imminent, industrial nations bordering this sea still treat it like a tip. Over 3.5 million tonnes of industrial waste and 70 million tonnes of dredged waste and sewage sludge pour into it each year.[1] Much of the industrial waste, including heavy metals and toxins like PCBs, comes from factories on the banks of rivers such as the Rhine, Elbe, Thames, Humber and Tyne. More pollution comes from shipping discharges, spillages from oil rigs and gas platforms, and from the incineration at sea (by Britain alone) of toxic waste.

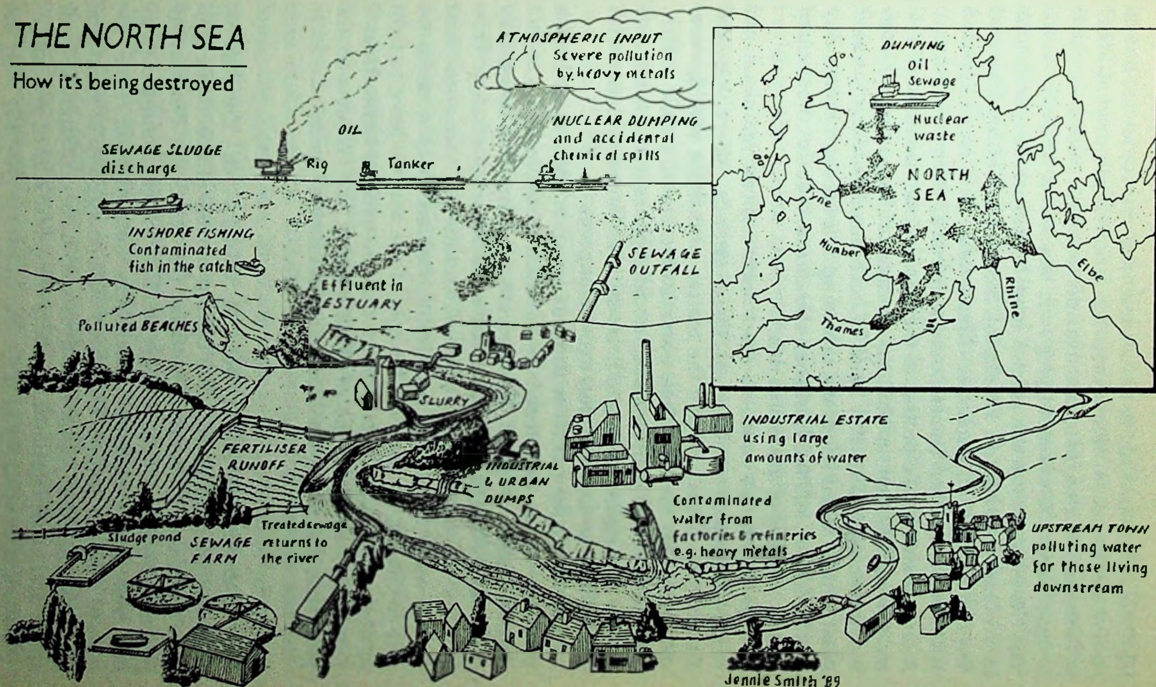
99 per cent of untreated sewage sludge dumped in the North Sea is British. We dispose of 30 per cent of our sewage in this way. There is fierce argument over how long excremental bacteria and viruses can live in the sea. Water and health authorities in the United Kingdom claim that most bacteria are killed by salt water and by such sunlight as the North Sea receives. Environmentalists and just about everyone else with a North Sea coastline disagree. The Germans are the biggest producers of sewage sludge and they stopped sea-dumping some

years ago in order to prevent further deoxygenation and fish-kill. At the 1984 North Sea Conference delegates claimed that the United Kingdom abuses the marine environment by continuing this practice. But the water industry now estimates that to obey a 1985 EEC directive on reducing the current level of marine sewage dumping would add £30 million a year to its sludge disposal bill.

Instead, money goes on justifying the practice. The Water Research Centre uses 60 per cent of its budget defending the two main disposal routes of sewage, and most of the rest on improving existing methods. A tiny amount is spent on innovation, such as composting processes that create a range of saleable by-products. Some RWAs have begun to show interest in new techniques. Anglian Water has been testing the sludge-free 'root zone' method of treating sewage in reed beds. Other methods under test include incineration, pyrolysis, land-filling and worm compost trials.[2] A further technique not yet widely used involves bioaugmentation. This involves addition of specific micro-organisms to the sewage to improve the quality of the biological clean-up. Such technology is said to be not only cheaper but more readily implemented than massive capital projects.[3]

Not only is Britain now the only North Sea state systematically dumping untreated sewage at sea, but by 1990 will be the only North Sea state still dumping its industrial waste in this fashion. With European alarm mounting over growing evidence of severe damage to the North Sea and its life, isn't it odd how Britain alone continues practices elsewhere found not only disgusting but potentially deadly? You'd think that an island race in particular would realise the need of maintaining, at whatever cost, the health of the sea that laps its shores. What species of abnormal insular psychology governs our seeming lack of concern is anyone's guess. Partly it's a matter of historical habit. We've been doing it so long we don't see why we should stop. Also, the 95 per cent of British sewage sludge collected via mains sewer is much higher than the percentage similarly collected in France or Germany. But these are poor excuses. The problem won't go away by being ignored. Nor is the EEC likely to let Britain get away with it.

The filthy state of many British beaches is one reason why, in June 1986, the government had to postpone its attempt to privatise water. Then, the government was unwilling to guarantee that, after privatisation, it would foot the bill required to meet


THE NORTH SEA
How it's being destroyed
ATMOSPHERIC INPUT
Severe pollution by heavy metals
DUMPING
Oil
Sewage
Nuclear waste
NORTH SEA
Tyne
Humber
Thames
Rhine
Elbe
OIL
SEWAGE SLUDGE discharge
Rig
Tanker
NUCLEAR DUMPING and accidental chemical spills
INSHORE FISHING
Contaminated fish in the catch
SEWAGE OUTFALL
Effluent in ESTUARY
Polluted BEACHES
SLURRY
FERTILISER RUNOFF
INDUSTRIAL & URBAN DUMPS
INDUSTRIAL ESTATE using large amounts of water
Contaminated water from factories & refineries e.g. heavy metals
Sludge pond
SEWAGE FARM
Treated sewage returns to the river
UPSTREAM TOWN polluting water for those living downstream
Jennie Smith '89

EEC directives not only to reduce lead and nitrate levels, but to restore golden sands.[4] Some years ago Brussels required all EEC governments to designate beaches and rivers for public use, and to ensure that the water outlying such beaches or banks is clean. The British response was poor. A mere 27 British beaches (none in Scotland) were listed. Blackpool, Skegness, Whitley Bay and Yarmouth were all excluded. Meanwhile, France designated 1,500 beaches. Even Luxembourg nominated 39 inland waters. After massive public protest to the Royal Commission on Environmental Pollution, in 1987 the number of designated beaches was increased to 391. But 24 of 71 such beaches along the east coast of the United Kingdom, including Scarborough South Bay and Southend, still fail European standards. None of them carry notices warning of the health risk.[5]

Does it cost too much to erect such notices, let alone put money in hand to clean up these strands where we and our children bathe? What's the matter with those who 'govern' us? Don't they see that clean water is essential to public health, without which no nation can be strong? Apparently not, because they're at it again, seeking to delay still further compliance with EEC directives to which they agreed long ago.

And what's the matter with us as a nation? Must *our* health continue to be threatened by outdated ideological conflict between left and right? The privatisation issue is essentially irrelevant. What is at stake is not ownership but quality. Who believes the chauvinistic cries of Canute-like ministers that British water is best just because it's British? Maybe we're too lazy to change, far less face the cost of the war we have to fight against our own bad habits before they do us fatal harm. Or is it just that we're ignorant of what's going on? What *are* the pollutants destroying the North Sea and its life?

Oil

The discovery of North Sea oil transformed the British economy. In 1984 alone, 1,208 million barrels of this black gold were extracted. Without oil revenue, the 'Thatcher Revolution' probably would not have happened. But the environment price has been huge. Spillages, discharges and disasters like the *Torrey Canyon*, *Amoco Cadiz* (58 million gallons of crude oil lost), and the Piper Alpha (166 lives lost) have contaminated our coasts and killed unknown numbers of seabirds, fish, and seals.

The number of shipping spills has fallen consistently over the

last few years. The same is not true of spills from offshore oil installations. ACOPS (the Advisory Committee on Pollution of the Sea) figures show that in 1986 alone, 541 tonnes of oil spilled into North Sea oilfields in 165 separate incidents — a figure over double the mean annual total for the previous six years. This excludes a spill of up to 2,000 tonnes of crude oil from Occidental's Piper/Claymore pipeline in November 1986. Though expected to break up in heavy seas, this spill ended up threatening Norwegian fish farms. The British oil industry is good at this. Ten out of 12 North Sea oil-rig slicks successfully traced in February 1986 came from UK rigs.[6] Presently there are 37 oil rigs and 58 gas platforms in the North Sea. The Piper Alpha tragedy raised as many doubts about the owners' regard for the health of the marine environment as it did about their concern for the safety of rig workers. All the other rigs and platforms remain disasters waiting to happen — so long as company profit comes before all else.

The North Sea is not our only oil-threatened marine region. Every autumn the 'Klondikers' gather off north-west Scotland. These are factory fishing vessels from as far afield as Bulgaria and the USSR. They have little compunction about discharging massive amounts of diesel and fish oil that weaken marine life. 'After the Klondikers leave in March we get no prawns from that part of the sea for at least two months,' Alan Downey, chairman of a local association of small boat owners, said to *The Observer*. 'The pollution they leave is horrendous. We can be bringing up dead fish for months.'[7]

Organochlorines

These include DDT (banned in Britain in 1983), PCBs (5 tonnes of which spilled from the Piper Alpha), and other pesticides that help make up the 100,000 manufactured chemicals now polluting the North Sea. Most are toxic to fish, and even more toxic to life-forms higher up the food-chain. The cumulative effect of PCB marine pollution has caused 80 per cent sterility in seals and (whatever industrial apologists who should know better insist) reduced their resistance to disease, so accelerating their death rate amid the virus infection (now thought to be a form of cattle plague, similar to canine distemper) that killed thousands of them in 1988. The good news is that the survivors and their pups seem to be gaining immunity to the plague.

Meanwhile marine discharge of phosphates and nitrates con-

tinues to encourage the growth of tiny organisms like phytoplankton. Their numbers have increased by 17 per cent over two decades. With what effect? Such organisms gobble free oxygen, that's what. In the North Sea there are now two 'black holes', each the size of Wales, in which oxygen levels regularly drop to zero, meaning that there are no higher life-forms.[8] This also helps explain the disease and death during 1988 of thousands of farmed fish from Norway to West Scotland. Algae, encouraged by pollutants, grew so rapidly that these fish (caged in sea-loch or fjord) suffocated. Such micro-organisms, whipped up by the tide, can result in the evil-looking froth that increasingly rolls in over our beaches and shores.

Not only do the higher life-forms rely on free oxygen: the higher a species in the food-chain, the greater the concentration of poisons. We humans are right at the top. Seals are one step higher a species in the food-chain, the greater the concentration of poisons. We humans are right at the top. Seals are one step below. As for sea birds, whose breeding success is at an all-time low, they rely on stocks of fish which not only are declining rapidly, but are ever more diseased. Porpoise and dolphin, once commonly seen off the north and west of Scotland, are increasingly rare. It is thought their breeding success is being adversely affected by eating nitrate-poisoned herring, also perhaps by pollution from the many fish farms (see below) in the region. Certainly, over a year of walking by the sea in northern Scotland every day, I have seen only one school of porpoise.

But fish stocks are worst affected. Shellfish like mussels and oysters are often heavily contaminated by sewage, as we saw, and by chemicals such as Nuvan 500, a controversial pesticide used to control sea lice on farmed salmon which, penned in cages like battery hens, easily fall prey to fungal diseases. Despite denial by fish farmers using this chemical (a by-product of which, dichlovros, is listed by the 1987 North Sea Conference nations as one of the 26 most dangerous chemicals in waterways), recent studies by the Norwegian Government's Institute of Marine Research at Bergen, and by Dr Peter Fraser of Aberdeen University's zoology department suggests that dispersal of this toxin into coastal waters from salmon pens is damaging mussels and oysters, as well as lobster and crab larvae. The Aberdeen research also suggests that increasing blindness in up to half the wild salmon in sea lochs on the West of Scotland (an area with over 300 salmon farms) is being caused by Nuvan

500.[9] There is also a risk of wild salmon being genetically contaminated by farmed salmon escaping or being released.

The threat to marine life posed by other pesticides such as Lindane, Dieldrin and TBTO has already been established. Further out to sea, a 1986-87 survey by the Dutch Institute for the Investigation of Fishery showed that 40 per cent of their 20,000 sample of plaice, flounder and dab had bacterial skin diseases or cancerous tumours. There was no evidence of natural viruses causing these diseases. Toothpaste whitening, paint, toxic waste and manure were implicated. The Institute recommended that these flat fish should no longer be eaten. A German survey released earlier in 1986 found 42 per cent of its fish sample to be diseased.[10] Evidence given by Greenpeace at the Second International Conference on the Protection of the North Sea in 1988 suggests that 50 per cent of North Sea fish now being caught (some 2.5 million tonnes annually) is diseased, suffering from ulcers and lesions.[11] But, also in 1986, the Ministry of Agriculture, Fisheries and Food declared that its regular surveys showed no such extent of disease in fish. No warnings were issued to the British public.[12]

Heavy metals

Cadmium, copper, chromium, mercury compounds (discharged in waste from paper pulp mills), nickel, lead and zinc are also implicated in this catalogue of disease and destruction of the marine environment. 'Whatever the action necessary to attain a healthy North Sea, it must be done within the next five years,' say Friends of the Earth. 'After that, the damage may be irreversible.'[13]

Scaremongering? Decide for yourself. These heavy metals enter the sea via rivers, direct discharges, or dumping. But the most prolific medium of heavy metal marine contamination is via the atmosphere. In the case of a substance like zinc, atmospheric input to the sea may be three times the level obtained from all other sources combined. Over 90,000 tonnes of iron degrade the North Sea via the atmosphere every year, and very little comes from other sources. Likewise, all manganese sea pollution arrives via the atmosphere, all the arsenic, most of the nickel and lead, and up to two-thirds of the copper.[14]

All these substances — sewage, heavy metals, organochlorines, oil and the rest — when casually released may too readily combine in ways as yet unknown to produce a new earth,

a new sea, a new problem. Water provides the medium for just about every chemical reaction known, so heaven only knows what sort of brews are stirring up in the North Sea and other enclosed marine areas as a result of the ingredients we so carelessly toss into the pot. One fears that the sorcerer's apprentice could have done no better, or worse. For virtually nothing we use in the kitchen, from pot to refrigerator to microwave oven, has been produced for our ease without some deleterious side-effect on sea, sky, river or soil.

An old story. Nothing comes free. Only in some cases the payment is more than we think when we use our flexible friend to pay at the till. Now the debt is being called in. We cannot so lightly break the links of what the ancients called 'The Great Chain of Being'. There is an invariable process of environmental cause-and-effect, and the realisation of it is leading to a new politics. Perhaps it will be a harsh politics. Perhaps it will have to be, if we are to be dissuaded from our expensive habit of ever-growing mass production and consumption.

Radionuclides

These reach the sea from the discharge or dumping of radioactive waste, and from other sources like Chernobyl. Waste from the Cap de la Hague nuclear reprocessing plant, and cooling water from all the nuclear power plants round the coasts, are chief culprits in the nuclear spoliation of the North Sea. Worst affected is the Irish Sea. Daily discharge of 2.2 million gallons of radioactively contaminated water from Windscale alias Sellafield makes this the most radioactive marine environment in the world. Is this a matter for UK pride? The Irish don't think so. There is also ever present risk of accidental spillage involving nuclear submarines or other nuclear-powered vessels. In the case of the former, tight military lips are unlikely to unbutton unless they have to. The myth of 'The Defence of the Free World' remains too potent among its adherents to acknowledge any such 'free' ecological assaults on the 'free world'. We just don't know how many such incidents, other than those admitted, have occurred to date in the seas round our coasts. Nor have we any way of knowing what long-term consequences might result. If only all that military resource and energy could be turned to fighting the *real* war! When will it start to happen?

THE ROYAL CRY

'Over the past century,' said Prince Charles in his opening address to the Second International Conference on the Protection of the North Sea in 1988, 'we have made it into a rubbish dump. The effluents we pour heedlessly into its waters are a threat to its delicate ecological balance. Some argue that we don't have enough proof of danger to justify stricter controls on dumping, or to warrant the extra expenditure involved. They say that we must wait for science to provide that proof. If science has taught us anything, however, it is that the environment is full of uncertainty. While we wait for the doctor's diagnosis, the patient will easily die.'[15]

At this conference, agreement was reached on reducing most forms of North Sea pollution. (Incidentally environmentalists were given just ten minutes to speak, five of which went to Greenpeace.) Toxic industrial waste-dumping must end by 1989. Incineration of dangerous liquids must be phased out by 1994. River pollution must be halved by 1995. Etcetera.

It was only a conference. Its resolutions were no more than words spoken from well-meaning mouths. To date, not even the agreement to set up a scientific body to discuss and monitor the outcome of the conference and its proposals has been achieved. The nation states involved are stalling on paying the money required to set up such a body. How much money? Less than you'd need to buy a house in Hampstead. We are talking about the princely sum of £175,000.[16]

'Too many countries help to make the law and then don't honour it,' said Stanley Clinton-Davis, ex-EEC Environmental Commissioner.[17] After the conference, everyone went home. Including Mr Clinton-Davis, out of No. 10's favour for not pursuing the crazy philosophy that claims that the bottom line is the profit margin. So the North Sea continues to die. Next time you meet a seal, say hullo. You might not get the chance again.

11
ACID RAIN

'Sheep shall eat men, men will eat sheep, the black rain will eat all things. . . .'[1] So runs a Highland prophecy attributed to the legendary seventeenth-century Brahan Seer. A longer version, describing the nineteenth-century evictions — the Clearances — concludes: '. . . the people will emigrate to Islands now unknown, but which shall yet be discovered in the boundless oceans, after which the deer and other wild animals in the huge wilderness shall be exterminated and browned by horrid black rains.'[2] Scots still dispute the meaning of these old foretellings. Nuclear fall-out? After Chernobyl, that's a fair bet. The oil boom, leading to black beaches and dead wildlife from Lerwick to Land's End? Maybe.

But another plague fits the bill, one now grimly obvious throughout upland Britain, in Wales, Yorkshire, Cumbria, and areas of Scotland like Galloway. And not only in Britain. This plague is as international as it is invisible, seen only by its effects — sparkling-clear lochs and rivers where no fish swim; blighted (literally 'browned') forests where no birds sing; wildernesses where animals are poisoned by eating plants, in turn toxified via infiltration of the roots by metals released from the soil by . . . acid rain.

And whatever one thinks of the prophecy, it's odd that it links 'black rain' with the eviction of Highlanders. For long before the threat of acid rain was realised, the industrial mentality of progress that evicted Scots from Scotland to make way for sheep also developed the conditions leading to the environmental catastrophe that we inherit. Two centuries ago, as Britain's first coal-fired 'dark Satanic Mills'[3] went to work, pouring out their destroying clouds of sulphur dioxide, William Blake asked: 'Shall we worship this Demon of smoke . . .?'[4]

It seems the answer remains 'Yes', despite the disaster of London's Great Smog of 1952. Every year of the 1980s up to 65 million tonnes of sulphur dioxide (SO_2), 9 million tonnes of nitrogen oxides (NO_x), plus hydrocarbons and other gases like

hydrogen fluoride, pour into European skies. Combining with each other and with water vapour in the atmosphere, they return to earth either as dry material, or in chemically complex forms as acid rain, and may travel thousands of miles, mutating all the way, before falling to earth, river, lake or sea.

Natural rainwater may be slightly acid due to absorption of carbon dioxide while falling, with a pH between 5.5 and 6.5 (a pH of 7.0 being the neutral level between acidity and alkalinity). Rain from polluted air over North America and northern Britain averages a pH between 5.1 and 4.1. One of the lowest (most acid) pH values yet recorded in Britain is 2.4, from rainfall over Pitlochry in Scotland. The pH of lemon juice is 2.0.[5] Industrially emitted sulphur dioxide, forming sulphuric acid as it travels through the atmosphere, causes some 70 per cent of the acidity in British rainfall. Nitrogen oxide (forming nitric acid) and hydrocarbons are the other recognised pollutants. These gases are emitted when fossil fuels are burned without adequate pollution controls. Power stations and heavy smelting industries (lead, iron, steel, copper and aluminium) cause all sulphur dioxide and about 75 per cent of nitrogen oxide emissions (vehicle exhausts produce the other 25 per cent). Nitrogen oxide reinforces damage caused by sulphur dioxide (see below). Mixed in sunlight with hydrocarbons (released by pine forests, by vehicles, or as solvents or from petrochemical plants), it causes dangerous 'episodes' (concentrations) of ozone. Ozone harms or kills leaf vegetables, flowers and crops such as beans, broccoli, maize, oats, tomatoes, cabbage and wheat, and plays an important role in damage to forests and wild plants.[6]

Some research indicates that hydrogen fluoride (HF), released from the same sources but a thousand times more toxic than sulphur dioxide, is in fact the major component in acid rain damage, and that toxicity, not acidity, is the main cause of damage. But the controversy over fluoride makes it hard to get at the truth. We will return to the subject later. Enough here to say that sulphur dioxide is generally regarded as the chief pollutant causing acid rain.

SULPHUR DIOXIDE

In an average year, the world's volcanoes vent a little less sulphur than Britain's power stations.[7] Department of Environment figures suggest that in 1982 British industries emitted

some 4.04 million tonnes of sulphur dioxide. This figure is close to an independent estimate for the same year of 4.2 million tonnes.[8] Emission levels in the United Kingdom have since fallen, due more to cutbacks in industrial production than to any commitment to clean up pollution.

Western Europe and Britain itself are not the main sulphur dioxide polluters. Of the 65 million tonnes that annually pour into European skies, about 21 million come from Western Europe, 40 million from Eastern Europe, with four million from sources unknown.[9] The most polluting and polluted areas lie in Eastern Europe. East Germany emits 240 kg of sulphur dioxide per head of population a year, or 35 tonnes per square kilometre. The Czechoslovak–East German border, the Upper Silesian coalfield in south Poland, and the Donbass coalfield in Soviet Ukraine near the Black Sea each receive an annual sulphur dioxide fall-out in excess of 12 grams per square metre over vast areas. This is twice the highest level of fall-out anywhere in Western Europe.[10] No wonder therefore that respiratory diseases have increased in lands like Poland. Acid pollution can travel far, once in the air, but still tends to fall (as rain or otherwise) close to the point of production.

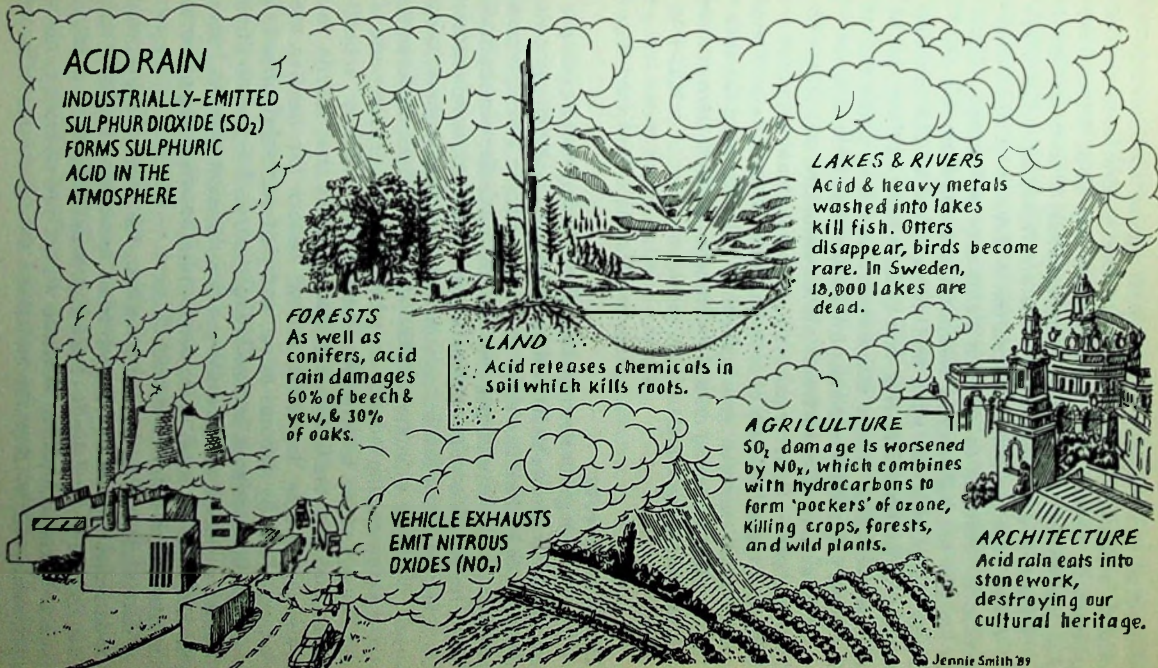
But its effects are as broad and varied as its fall is international. And sulphur dioxide, though the major component in the mix, is still only one of many. The more chemicals in the cocktail, the harder it is to know exactly what is causing the damage.

THE HARM THAT ACID RAIN DOES

Harm to the land

Acid rain acidifies the soil on which it falls. Fertile soils are usually alkaline. Lime has to be added to acid-damaged soil to restore alkalinity. Thus land overdosed in one direction must be overdosed in the other to restore it approximately to its original state. This sounds not unlike treating heroin addiction with methadone — create a drug problem to solve a drug problem. Can it be healthy?

In addition, acid rain reacts with otherwise inert metals in the soil like aluminium or cadmium, releasing harmful salts like aluminium sulphate which can infiltrate the roots of trees and plants. Many now believe that this process, rather than acidity itself, causes most of the 'acid rain' damage to flora and fauna.


ACID RAIN
INDUSTRIALLY-EMITTED SULPHUR DIOXIDE (SO_2) FORMS SULPHURIC ACID IN THE ATMOSPHERE
FORESTS
As well as conifers, acid rain damages 60% of beech & yew, & 30% of oaks.
LAND
Acid releases chemicals in soil which kills roots.
LAKES & RIVERS
Acid & heavy metals washed into lakes kill fish. Otters disappear, birds become rare. In Sweden, 18,000 lakes are dead.
AGRICULTURE
SO_2 damage is worsened by NO_x, which combines with hydrocarbons to form 'pockets' of ozone, killing crops, forests, and wild plants.
VEHICLE EXHAUSTS EMIT NITROUS OXIDES (NO_x)
ARCHITECTURE
Acid rain eats into stonework, destroying our cultural heritage.
Jennie Smith '89

Whichever way round it is, everyone agrees that damage is caused, and that industrial activity lies at the 'root' of the problem. In Sweden, 30 species of moss and 12 of lichen have disappeared or are in decline. Fungi essential to trees are dying in Holland. Fragrant and frog orchids are vanishing in Cornwall. In Wales, even the common primrose is threatened with disappearance.[11] Animals eating such plants may be harmed. Moose in Norway are poisoned by cadmium released from the soil.[12] These toxins may also wash into rivers, lakes, or the drinking supply. Thus fish and insects, and birds feeding on them, are at risk, as are human beings, either from aluminium poisoning, or from lead poisoning that results from acid-stripped lead pipes.

Acid rain can also react with nitrate-saturated soil. Some 50 kg of nitrogen — from car exhausts and agricultural ammonia — falls on a typical hectare of a German forest each year. Trees gobble up this nitrogen, growing rapidly taller, making the shortage of other nutrients critical.[13] Nitrogen leached from soil in this way also tends to end up in groundwater, river . . . or lake or in us.

Harm to forests

Acid rain damages or destroys trees like beech, yew (over 60 per cent of these species in Britain are damaged), oak (30 per cent damage), Scots Pine and silver fir. Some southern West German states have lost over 90 per cent of their silver fir; over half all West Germany's coniferous trees are now damaged; woods covering 2,000 square miles are classified as 'completely devastated areas'. On some estimates 47,000 jobs in the German forestry and wood processing industry may be lost.[14] The precise route of the damage is not understood. Some (the 'bottom-up' school) claim that acid toxifies aluminium into salts that invade the roots; others (the 'top-down' school) believe the needles are damaged first, by airborne ozone, and that acid rain and mists wash out the nutrients, in time killing the tree.[15] 'Speak to three German scientists and you will get five different theories,' said Sir John Mason, head of an Anglo-Scandinavian enquiry into the problem, in September 1988.[16]

Meanwhile, in the United Kingdom, for years the Forestry Commission insisted that British trees 'are in good health'. On a visit sponsored by Friends of the Earth in Scotland in 1984, it took a German forester, Joachim Puhe, just five days of a nationwide tour to discover and point out that huge areas of

Cumbrian trees with browned needles and lost shoots showed undeniable signs of acid rain damage. The Forestry Commission, embarrassed that a foreign forester had spotted this first, expressed concern that local staff hadn't seen or reported this major epidemic earlier. 'These days they spend all day logging stock yields on their computers, rather than being out in the forests,' one Forestry Commission executive told writer Fred Pearce.[17] Subsequently, in 1985, the Commission inaugurated a 'damage-monitoring day', on which staff leave green screens for the not-so-green trees. And in 1986 the Commission stated that, in Britain: 'We have appreciably more trees in the slightly and moderately damaged categories . . .' than does West Germany.[18]

What do you look for in acid-damaged trees?

- reduced shoot-growth and dieback of lateral branches;
- short shoots broken off by wind;
- clustered, crinkled, yellowed leaves growing shorter than usual;
- green leaves lost from June onwards;
- split bark and abnormal branching patterns.[19]

Thus, to date nobody seems quite sure exactly what role acid rain plays in the accelerating death of forests all over Europe. In fact we are not much better off in this than medieval Europeans were in understanding the epidemiology of the Black Death. The causes of damage are too complex for easy understanding. Yet again we are meddling in nature like children with matches in a gunpowder factory. But should we just cry:

Rain, rain go away —
Come again another day!

Harm to lakes and rivers

Acid rain can reduce the pH of lakes and rivers to a level inconsistent with the survival of fish or other higher life-forms. 50,000 Canadian lakes are at risk; in Sweden, at least 18,000 lakes are completely acidified — dead. In Norway, 5,000 square miles of lakes are devoid of fish, while brown trout, already extinct in 1,750 lakes, are expected to have vanished from 80 per cent of southern Norwegian lakes by 1990.[20]

Many lochs in south-west Scotland are dead or near dead — Loch Fleet, Loch Enoch, Loch Skerrow, and the Round Loch of

Grannoch, to mention a few. Plant fish here and they won't last a fortnight. The water is too acid; the metals washed into it clog up the gills of the fish. Further north, in the granite regions of the Cairngorms, a similar tale develops. Falls of black, acid snow lead to fears that the fish of Balmoral and Lochnagar may soon be extinct. Elsewhere too the black rain's effects are felt. In Cornwall, the natterjack toad is at risk. In Cumbrian reservoirs, fish found in 1975 are gone. In Wales, salmon and trout are dying out. In September 1984 over a hundred sea trout and other fish were found dead on the banks of the Afon Glaslyn. The murderer? Acid poisoning, and the aluminium that the acid had washed into the stream.[21]

The problem is not only the steady increase in the acidity of these waters, but of sudden 'pulses' of intensely acid input from storms, with which fish cannot cope. Many streams, especially in the granite areas of Scotland, carry no calcium to neutralise these pulses. In one Cumbrian storm, the pH of Blea Tarn fell from 6.0 to 4.1 — almost a hundredfold increase in acidity overnight.[22]

The decline in fish affects other water-life. Otters are in decline in Dumfries and Galloway. As for birds, some species are temporarily favoured by acidification. Duck and goldeneye prosper due to reduced competition with fish for common insect prey. Fish-eaters like divers and mergansers find compensation for fewer fish in that the clarity of acid water makes it easier for them to see their prey. Other species, like osprey and tern, fishing at the top of the water, benefit not at all. And all waterbirds — especially those mating in territories close to the shore and feeding on emerging insects — are increasingly exposed to aluminium and other metal poisoning.[23] The result? Impaired breeding success. 3,200 pairs of Swedish osprey (60 per cent of the European population) are at risk. In Finland, pied flycatchers are breeding poorly; their egg shells contain high concentrations of heavy metals.[24] Scotland's dipper population is declining, and in Wales has suffered a 70 per cent loss in recent years.[25]

Harm to architecture

Acid rain eats ancient buildings. From Athens to London, Europe's architectural heritage is being corroded at an alarming rate. In the last 24 years the Acropolis in Athens (Europe's most polluted city) has suffered more damage than in the 2,400 years

since it was built. The caryatids, giant marble pillars carved in the shape of women, are breaking up. The acid eats into the marble, and converts it to crumbly gypsum. In Italy, Renaissance frescoes are also breaking up. Gypsum pustules are forming in the plaster on which they were painted. Few doubt that acid rain is the cause.[26] In London, the stonework of St. Paul's is being eaten away at a rate of one inch every century. Beverley Minster, where 'the decay is indiscriminate', and Lincoln Cathedral, in the path of pollution from power stations in the Trent Valley, are significantly damaged, while the corrosion rate in Birmingham is over 20 times that found in rural areas.[27] Damage to Cologne Cathedral is costing £1.5 million to repair every year, while the tragic deterioration of the priceless medieval stained glass windows of Chartres Cathedral is also ascribed to acid rain.[28]

All over Europe, the world's most heavily polluted region, history in stone falls apart before our heavy, supermarket-saturated eyes. Again, we pay for our habits not just at the check-out till. Here in Britain, as usual, the government stalls.

ACID POLITICS

It may be a surprise to learn that Britain, which until the mid-1960s had the filthiest air anywhere in the world, is now well down the league. In 1982, sulphur dioxide emission in the United Kingdom was some four million tonnes.[29] Since then this volume has fallen by 25 per cent, due largely to industrial recession. This decline has led researchers to seek evidence of acid waters becoming less acid. Yorkshire's reservoirs provide early evidence that this in fact is happening. The average pH of all three reservoirs in Calder Valley west of Halifax rose between the late 1970s and 1985 — in one case from 4.6 to 6.1. This evidence is unwelcome only to those industrial apologists who still insist that acid soil, not industrial pollution, is responsible for the acidification of water and subsequent death of flora and fauna.[30]

Why then, if UK SO_2 levels are falling, are the Scandinavians still furious with us? It's an old story. Britain has been exporting pollution to Scandinavia for over a century. In 1886, 60 years after William Blake wrote of 'dark Satanic Mills' and 20 years after salmon began to die in acid-poisoned rivers west of Glasgow, the Norwegian playwright Henrik Ibsen wrote:

Direr visions, worse foreboding
Glare upon me through the gloom,
Britain's smoke-cloud sinks corroding. . . .[31]

Ibsen's ancestors feel much the same way about it today. Two-thirds of British sulphur dioxide pollution escapes through the tall stacks of coal-fired power stations which in 1983 contributed 65 per cent of total output. These tall stacks may well ensure reduced *local* sulphur dioxide pollution, but by throwing the gases higher into the air-stream they not only encourage a longer-range (international) distribution, but the increased likelihood of such pollutants falling as acid rain.[32] And, given the prevailing south-westerly air-stream, this means that Norway and Sweden catches what we throw at them.

With what results? We have described some. 18,000 Swedish lakes dead, brown trout vanishing from Norwegian lakes, poisoned moose, poisoned people — an ever-lengthening catalogue of disaster for which Britain bears at least some responsibility. But not all. It's human nature to blame one's own faults on others. The truth is: Sweden produces most of the acid rain that kills Swedish fish, and East Germany, Czechoslovakia and Poland contribute more acid rain to Sweden than does Britain.[33] As the Swedes acknowledge — they are aiming for a 65 per cent cut in their own SO_2 output by 1995.[34]

Even so, British industry *is* implicated. July 1985 was a bad month for southern Norway: of seven acid downpours, with a pH as low as 3.6, three came from Britain.[35] But British authorities have still to acknowledge their contribution and join the international movement to cut such pollution. In 1985 Central Electricity Generating Board (CEGB) chairman Lord Marshall authorised the spending of £300,000 on a 30 minute 'educational' video film about acid rain. In this film lake acidification was blamed on tree-planting above the tree-line. The Norwegians were so angered that their prime minister complained about it at a summit meeting with Mrs Thatcher. Norwegian scientists at a press conference in London stated that the video 'concealed and twisted facts'. Even the CEGB's own scientists discreetly publicised their own annoyance at this official backing for what they felt to be an unsound case.[36]

Also in July 1985, 21 states pledged to achieve a minimum 30 per cent cut in their 1980 levels of SO_2 emission by 1995. Britain, along with Poland, Spain, Greece and Yugoslavia, remains

among the few sulphur dioxide polluters who refuse to join this '30 per cent club', claiming that there is insufficient evidence to justify action, instead sticking to the 'aim of policy' of a 30% cut by the year 2000.[37] And this even as even as evidence emerged that much higher cuts — of up to 90 per cent sulphur dioxide and 75 per cent in nitrogen oxide — are needed, and soon, if irreversible harm is not to be done globally.

Worse still, in late 1986, Department of Energy Predictions of future energy demand in the United Kingdom implied increases of up to 30 per cent in sulphur dioxide emissions from British power stations by the end of the century. The same year Lord Marshall stated that fitting FGD (flue gas desulphurisation, see below) to three British power stations by 1997 would 'ensure that our emissions of sulphur dioxide continue to decline through the remainder of this century'.[38]

The strangest aspect of UK reluctance to stop poisoning our neighbours, let alone our own lakes and forests, is that not only does the technology exist to clean up 95 per cent of sulphur dioxide pollution (and 90 per cent of nitrogen oxide pollution), but that the British invented it.[39] Flue gas desulphurisation was first successfully tried on a Manchester power plant in *1880*. Battersea Power Station, built in 1929, operated an FGD system that cleaned up 80–90 per cent of the plant's smoke for most of its working life.[40] Yet currently, while 80 per cent of West German power-plants are FGD-fitted, the score in Britain is precisely zero!

Some British companies, including the CEGB, are now preparing for an FGD programme more ambitious than that announced by Lord Marshall in 1986. They are making deals with Japanese firms to install on British smokestacks the Japanese version of what the British invented.[41] In so doing, the government and CEGB apparently mean to break commitments made to conservationists in mid 1987 when, forced by an EEC directive to expand their FGD programme, plans were announced to install FGD at five or more coal-fired power stations.

The problem is that there are different FGD processes. The old 'Wet FGD' method requires huge amounts of high-grade limestone, and also creates mountains of gypsum sludge, which have to be dumped. In 1987 the Junior Environment Minister Lord Belstead promised that the British FGD programme would be balanced between this process and a newer technique that recycles the limestone, and uses only about 8 per cent of that employed in the other.

In early 1989 the authorities changed their tune. 'Circumstances have changed quite considerably with privatisation,' said a CEGB spokeswoman, 'The new private companies that will take over the industry next year cannot be bound by what was decided by the CEGB two years ago.'[42] This means that plans to install a lime-cycling plant at Fiddler's Ferry power plant on Merseyside and a limestone-gypsum plant at the Drax power station near Selby may now be scrapped. This means that the privatised CEGB will replace one kind of pollution with another by relying on an older, dirtier FGD process which may lead to spoliation of areas like the Derbyshire Peak District and the Yorkshire Dales. 'If they are allowed to get away with this,' said Amanda Nobbs of the Council for National Parks, 'we believe it is inevitable that large-scale quarrying will start up in the national parks and other areas of outstanding national beauty.' And also inevitable that dumps for thousands of tonnes of gypsum will have to be found, creating yet more ugliness and potential pollution. Meaning, yet again, the cheap, unimaginative option rather than any commitment to the environment. How green is our government? About as green as our valleys will be by the year 2000, if this goes on. About as green as a dollar bill.

What really boggles the mind is the sheer lack of enterprise. Where is the investment in new technology, in new ways of thinking and seeing? In a letter to *The Sunday Times*, Professor D. Cole-Hamilton of St Andrews in Fife bemoans the lost chance, asking why no thought is given to an alternative process, involving catalytic conversion of sulphur oxides in the flue gases to sulphur trioxide. The only raw materials involved would be the gases, air and water, the catalyst in the converters being continually recycled. The product would be sulphuric acid, the sale of which would help to recoup the high initial capital costs of installation.[43]

Likewise, little attention has been paid to the possibility of burning low (less than 1 per cent) sulphur coal. Why? Perhaps because such coal is found in Scotland and south Wales, where British Coal is shutting pits as fast as it can. Canadian coal with a sulphur content of 0.3 per cent is already supplied to some West German power stations. However the British government seems to be unwilling to let the CEGB buy it.[44] The preference is still for the cheaper, albeit dirtier, option. And there's the rub. With privatisation in the offing, who in the present government wants to consider high initial capital costs when their chief

concern is to attract investors with hopes of short-term profit? And what if it turns out that sulphur dioxide isn't even the chief destructive agent in acid rain damage?

How about our old friend and dental preserver, fluoride?

Hydrogen fluoride

The gas hydrogen fluoride (HF) is emitted from many of the same sources as sulphur dioxide and nitrogen oxide, yet is almost impossible to control, even with FGD scrubbers. It is known to be 1,000 times more toxic than sulphur dioxide, yet there is no pollution standard for it, even though the United States Department of Agriculture has reported that: 'Airborne fluorides have caused more damage to livestock than any other air pollutant. Whenever we find damage to animals we also find fluoride damage in some humans. Man is much more sensitive to fluoride than animals.'[45]

What sort of damage? The Geneva Division of United States Steel in Provo, Utah, funded a seven-year study that involved the observation of cows fed with increasing levels of fluoride in their forage, to the point where their teeth rotted and they became crippled. Gladys Caldwell has found 80 ppm of fluoride in plants off Sunset Boulevard in Los Angeles.[46] When a tribe of Indians on Cornwall Island in the St Lawrence River reported that their cattle were dying, a team of scientists from Cornell University found that fluoride from the Reynolds Metal Company across the river in New York State was to blame. Forage with as little as 15 ppm of fluoride was at fault.[47] Douglas L. Sisterson, researcher with Argonne National Laboratory, working on a United States Environmental Protection Agency grant, advised in 1981 that: 'Nearly all our samples (of acid rain) contained detectable amounts of fluoride.'[48] When Mount St Helens blew up in 1980, fall-out samples showed 202 ppm fluoride. Washington and Oregon State Health officials told farmers to use this ash as fertiliser even as the United States Department of Transportation warned pilots to avoid any exposure, saying: 'Volcanic ash from Mount St Helens has been analysed and found to contain abrasive and corrosive material such as fluoride and sulfuric acids'.[49]

One can go on and on. The World Health Organisation reports that we retain 50 per cent of ingested fluoride. Canadian Research Council evidence warns that: 'Fluoride is a persistent bioaccumulator, and is entering into human food and beverage

chains in increasing amounts'.[50] Clinical research shows that while sulphur dioxide affects only the upper respiratory tract (bad enough), fluoride can also get into the lower tract and blood stream, and accumulate in bones, teeth, and all organs and cells. All available evidence suggests that fluoride, in whatever form, is maybe the most dangerous of all the toxins described in this book.

Living in a 'free' society, being persuaded that councils of government and boards of industry are crewed by essentially decent folk like you and me, we may find it hard to believe that such a toxin could deliberately be foisted upon us. They wouldn't do it to us . . . would they?

It is difficult to get at the truth. All one can say is: there is rarely smoke without a fire, and, where acid rain destruction is concerned, there is still a missing link. Is hydrogen fluoride implicated? If so, we certainly won't learn about it from those who want to sell it to us in our water or our toothpaste. Acid rain, it may be, not only damages forests and waterways and the life depending upon them, but the human conscience.

Which brings us, it may also be, to water privatisation.

12
PRIVATISATION

Nations alarmed by the CFC threat to the ozone layer recently agreed to a 100 per cent ban on chlorofluorocarbon use by the year 2000. One conference on this issue took place in London, hosted by a prime minister who seven years ago said of the Falklands campaign that: 'It is exciting to have a real crisis on your hands when you have spent half your political life dealing with humdrum issues like the environment.'[1]

Now Mrs Thatcher says that saving the environment is 'one of the great challenges of the late twentieth century' even as Environment Minister Mr Nicholas Ridley launches leaflets, titled *Environment in Trust*, each of which is prefaced: 'The Government has the responsibility to protect the natural environment from any harmful effects of human activity.'[2]

Too good to be true? With the government in trouble over environment and health issues, such claims are no surprise. Yet a more familiar ideology prevails where privatising natural monopolies like water and electricity is concerned. Cracks in the green facade appear when ministers are pressed to enforce measures needed to convert fine words into action. They espouse a 'voluntary approach', though surely both human nature and history suggest that nobody, let alone large industries, ever abandoned profitable habits without being pressurised. As MP for a Cotswolds constituency where rivers like the Coln are visibly dying as a result of over-abstraction, Mr Ridley of all people should know it. The proposed National Rivers Authority (NRA) may be able to apply such pressure, but the case is not yet proven.

1989's shift towards privatisation is not the first. The policy was launched, without public consultation, in February 1986, but sank in four months. Its flaws included the proposal that water authorities be sold with all self-regulatory functions intact, meaning that, as PLCs committed to stockholder profit, they would supervise the quality of their own product. The CBI opposed this, stating that one private company should not

exercise statutory control over another. Environmental groups like the Council for the Protection of Rural England (CPRE) obtained Counsel's Opinion that private regulators would probably be illegal under EEC law.[3] This opposition resulted in proposals to establish the National Rivers Authority. Also the government ran foul of EEC law, refusing to comply with directives on the clean-up of British beaches and the reduction of lead and nitrate water pollution, knowing that the huge capital costs involved would discourage investors.

A new launch is now underway. It is intended that by November 1989 at least 51 per cent of the vast assets of the ten RWAs (declared net value in 1987–8: £8,787 million) will be in private hands. The government is set to make a mint from the exercise. But again the ship leaks even before it's in the water. It's hard to justify privatisation of an industry that requires massive investment to meet the challenges of the private sector and the demands of regulation. Yet again EEC approval is sought for further 'temporary' non-compliance with water quality directives so as to present a more attractive nvestor package. A confidential water industry document dated May 1988 and leaked to Friends of the Earth states: 'The Department of the Environment are taking the lead in this and they must succeed'. In early 1989 a water authorities spokesman told *The Guardian*: 'If we have got hanging over us the threat of cases in court, it is not the best background to flotation',[4]

Yet the EEC refuses to lower water standards, and doubts about or hostility to one aspect or another of the measure are expressed by 75 per cent of the public, by consumer groups, conservation groups, the City, much of the media, and by some in the water industry itself. Not least is the public fear that the sale will lead to poorer water quality, higher prices, and damaging exploitation or sale to commercial interests of the thousands of acres of wilderness, much in National Parks, that are owned by the RWAs.

Alarm bells have been ringing. 'You can save money by letting the water quality deteriorate,' said Ron Packham, President of the Institution of Water Quality and Management in 1987, 'there is clear evidence that this is going on now.'[5] In 1988, Mrs Jenni Colbourne, a scientist with Thames Water Authority (1987-88 profit: £221.4 million), expressed fears that flotation may lead to: 'an unregulated industry, just there to make money'.[6]

Dr James Dunlop, Director of Community Medicine and Environmental Health in Hull, where NHS bottled water was issued to babies at risk from nitrate intake, feels that 'unless tremendous safeguards are written into the privatisation programme, there are tremendous dangers'.[7]

What kind of dangers? The National Consumer Council opposes existing proposals for water and electricity privatisation on the grounds that consumer protection is inadequate. In neither case, says Baroness Oppenheim-Barnes, chairwoman of the government-funded council, 'have the standards been properly defined, except in a few cases, and they are hedged around by get-out clauses and complicated enforcement procedures'. She adds that, though providing unwholesome water will be illegal, unless a company continues to provide substandard water, it 'does not have to compensate the customer, even if their goldfish has already died, your hair has gone green or even if the water has made you ill. This is not nearly good enough'.[8]

Mr Andrew Lees of Friends of the Earth warned similarly when, after alum poisoned 20,000 people and 60,000 fish in Cornwall, it emerged that a loophole in the 1974 Pollution Act meant South West Water could be prosecuted only for poisoning the fish, not people. 'Under the draft bill,' said Mr Lees, 'massive private companies will be able to poison the water of entire cities without being prosecuted. But someone who fails to repair a dripping tap, or takes a kettle of water to a neighbour because she cannot afford to pay the bill, can be taken to court and fined.'[9]

Meanwhile water authorities discharging persistently illegal levels of sewage have been invited to ask for relaxation of their pollution standards in the run-up to privatisation, as they cannot sign flotation prospectuses if committing persistent criminal offences.[10]

Then, the matter of price. 'Bills set to double after water sell-off' states *The Observer*, explaining that, though huge capital investment (the government claims £3 billion, other estimates are double) is necessary to clean up British beaches and rivers, rebuild sewers, and bring our water up to EEC standards, other costs, to instal water meters and pay for the sell-off itself 'may be of little benefit to the consumer'. Water-metering may cost up to £2 billion, and no satisfactory system yet exists, while the annual charge for privatising the WAs will probably be about £850 million. The new PLCs will also pay corporation tax and VAT, which will be passed on to the consumer, as will the cost of

the current advertising campaign.[11]

No surprise there is public concern. The Catch-22 is plain. It is 'unavoidable capital expenditure that makes the flotation in November look so fraught with difficulty,' declares *The Daily Telegraph*, adding that the government 'can no longer pass off the increasingly glaring conflict of interest between potential shareholder and consumer. Few consumers are now under any illusions that the privatisation of water will mean a substantial increase in bills. Yet any attempt by the government to force down those bills makes water less attractive for the investor.'[12] *The Guardian* concurs that the policy as presently conceived 'looks like alienating the consumer (through huge price increases) while frightening off potential investors.'[13] *The Scotsman* concludes that privatisation policy 'has become a monster which cannot be satisfied or controlled', adding that 'it is so ideologically driven and so productive of revenue that tampering with it in any real sense requires a major admission of misjudgment if it is to be slowed down, or even stopped'.[14]

Such an admission being unlikely, it seems that come November 1989 water used by 50 million people will be sold into the private sector, though a recent statement by junior environment minister Michael Howard suggests that only 51 per cent of shares will be sold initially. This in itself, following government failure to block huge price rises by private statutory water companies (SWCs) from April 1989, shows ministers wilting under fire. So too do various devices plucked from the ministerial bag to reassure us that privatisation will not lead to a fall in health and safety standards even as prices rise. Yet if prices are not to be set by companies responding to market forces, what is the logic of privatising at all?

PRIVATISATION — PROS AND CONS

Those in favour of privatisation claim that it will lead to greater efficiency in an industry which, in areas like sewerage, is in a shambles due to years of feather-bedding. They claim that competition will improve the service, given good regulation and public share-owning scrutiny. They justify years of neglect by asking how government can regulate a public service without cutting corners in the interests of the wider national economy. They argue that, as costs must in any case rise to meet public and EEC demands for a

cleaner environment, the only real objection cannot be to privatisation as such, but to the way government ministers have to date handled the deal. The fault lies not in the policy but in the government's front bench stars. They insist that mounting public (and City) doubt as to the wisdom of the sell-off can be allayed simply by fine tuning. Let the new utilities keep the sale proceeds for necessary investment, say some. Sell preference, not ordinary shares, as the existing SWCs already do, suggest others. Then all will be well. So privatisation's apologists claim.

Yet all this denies the public perception that water is a common need which no special interest should be allowed to exploit for private gain. It denies the public sensation that crude market competition is no way to regulate a substance upon which we rely for our very existence. It ignores public unease that water has become yet another pawn in an ideological game of profit and loss foisted on us by a government which apparently believes that the main purpose of government is to encourage individuals to water their own patch at the expense of others. Most of all, it ignores a deeper constitutional issue. Why should we bother to elect governments at all, if government refuses to administer the common good in a responsible manner? Did our ancestors spend centuries developing a social system of democratic accountability only for it now to be abused by elected agents who behave more like used-car salesmen than trustworthy guardians of the common good?

Now for the specific questions and fears about water privatisation, and how it will affect the majority of British residents.

Quality control

This problem may be met, where environment and water quality are concerned, by the proposed establishment of a National Rivers Authority (NRA) to oversee these matters ('national' meaning England and Wales: Scots and Northern Irish may find the term national in this context revealing). Creation of the NRA, with an initial 6,500 staff (drawn from the old WAs) spread round 50 regional headquarters, is seen by conservationists as a positive step, whether water be in private or public hands. Doubts remain as to how independent the NRA will prove, especially if required to sub-contract some functions out to other bodies, including the Water Utility PLCs (WUPLCs) whose product it will presumably regulate. Both Thames and Severn-Trent WAs have said their privatised successors will not tender for NRA services,

while the government seems to be retreating from the idea.[15] Another area of doubt concerns the willingness of the NRA to prosecute WUPLCs for inferior water or sewage quality. In Scotland, the river purification boards have never once in 14 years taken a regional council to court for operating a persistently illegal sewage works.[16]

In addition to the NRA, HM Inspectorate of Pollution, the Department of the Environment, the Ministry of Agriculture, the Monopolies and Mergers Commission, and the European Community will all retain a regulatory role, though the precise duties, powers and links between these bodies have not yet been fully worked out.[17]

Under the Bill, the NRA will own the water resources, and will not only license the new bodies to abstract water, but oversee its quality. Though after the sell-off a moratorium on prosecution by the NRA may be temporarily required to accomplish the necessary investment programme to improve sewerage and water quality, vigilance will be needed to ensure that the bodies do not drag their heels on carrying out this low-profit but utterly essential programme. Likewise it remains to see how effective the NRA will prove in controlling over-abstraction of water from river or borehole by the WUPLCs. To date, the 1963 Water Resources Act, designed to stop rivers running dry, has been so flagrantly ignored that many rivers from Yorkshire to Kent and the Home Counties have suffered. Some, like the Slea and the Coln, are virtually dead. Certainly, water authorities have been put under pressure by the huge growth in housing and industrial demand. But if water dries up, so will growth.

It is plain that much will depend upon the efficiency, independence and clear brief of the NRA. At present the relationships and functions of the various bodies involved in pollution control management seem confused.

Price control

The Water Bill specifies that basic water supply and sewerage services are to be administered by Water Utility Public Limited Companies (WUPLCs), one for each water authority area. The 10 WUPLCs, along with the 29 smaller SWCs, will have charges to the consumer set by the Director General of Water Services (DGWat) who will head another new body, the Office of Water (Ofwat). Ofwat will apply the 'RPI-X' price regulation

formula used by other privatised bodies like British Telecom and British Gas. RPI (retail price index) is inflation. X, set by DGWat at 10-year intervals, measures a WUPLC's performance over a range of factors including the PLC's cost, efficiency, levels of service, EEC water quality requirements, and other factors. The efficiency of any one WUPLC will be compared with any other and against the industry's average, creating what is called 'yardstick' competition. No single company can influence the setting of X. It is hoped this system will spur efficiency, and that shareholder satisfaction or otherwise will provide a further spur.[18]

Another factor, Y, measures debt financing, tax dividends, and the huge capital investment needed. It will, when added to RPI and X, give K, the maximum that WUPLCs can charge. This may be up to four points above RPI. If inflation averages 5 per cent between now and the year 2000, this would mean annual price rises of 9 per cent per annum, doubling water charges in eight years.[19] Even before privatisation it grows clear that this system, so complex on paper, may prove even more arcane in operation.

The Water Companies Association (WCA), representing 28 of the 29 SWCs in England and Wales, shook the government in February 1989 by announcing that its members' charges were to be raised 'by 30 per cent or more' from 1 April 1989. Carpeted by junior environment minister Michael Howard, WCA spokesmen said capital investment needs arising from EEC water directives made such rises (in one case, rumoured to be 70 per cent) appropriate — especially with the strict new regulatory regime soon to be introduced.[20] Mr Howard's threat to refer these rises to the Monopolies Commission has not so far produced the desired effect. The SWCs are pressing ahead with their price rises. 'Clearly it is for each company to take decisions on the level of charges,' declared WCA chairman Mr Jack Jeffrey.[21]

The row raises the spectre of what will happen after privatisation when WUPLCs are squeezed between K on the one hand, and the EEC on the other. Where will they get the money to comply with Brussels' demands if they cannot charge the consumer directly? One likelihood is of a substantial increase in capital borrowing, with interest charges indirectly passed on to the consumer. The government may well tell the WUPLCs they cannot charge over K; the WUPLCs will say that either they increase charges or break EEC law. The consensus of opinion is

that Brussels will win the day. Yet apart from raising money by increased direct charges, the WUPLCs will have other cards up their sleeve. The threat of these cards being played greatly alarms wildlife groups, conservationists, and ramblers.

Land development

The area of land and water owned by the English and Welsh water industry is estimated to be 455,765 acres.[22] Three-quarters of this acreage, about 335,000 acres, an area the size of Berkshire, is of conservation or recreational value.[23] Most of this acreage is land. Water authorities own 10 per cent of the Peak District National Park, 7 per cent of the Lake District, and five per cent of Dartmoor.[24] Also they own freehold land, especially in south-east England, with huge development potential. The recent surge of corporate investment in private statutory water companies underlines the threat. Mid Southern SWC owns freehold land at an estimated cost value of £2.4 million, yet its current development value (in the high growth region of Berkshire and North Hampshire) is nearer £200 million.[25] No wonder French water companies like Lyonnaise des Eaux, Génèrale des Eaux, and construction companies like Cémentation-SAUR have been buying up the SWCs. A bargain is a bargain. Such companies (likely to be more interested in land development than in UK water quality) currently have stakes in 16 of the 29 SWCs, whose share values have increased by up to 40 times their 1987 level.[26] Meanwhile the water authorities too are buying into the SWCs; gaining 'free market' experience.

So, when WUPLCs are squeezed for cash, they'll be tempted to 'realise their assets' and sell surplus land for housing, industrial or recreational development. The rest they may utilise by charging the consumer (already paying more for water supply) for access to reservoirs or the surrounding land.

Currently only water authority land defined as 'surplus to operational requirements' can be sold off and developed. Between 1984 and 1987 some 580 acres of water authority landholdings were sold, most by Anglian (267 acres).[27] But goalposts can move, as recently downgraded sewage disposal quality requirements show. Technical development and more tightly defined service areas may lead to increasing acreages being defined as 'surplus', and the scope for asset development is considerable. 'There are still legal constraints on us as a public body but our attitudes are changing,' says the Managing Direc-

tor of Thames Water Authority. 'Now we are looking at our sites as assets in the broadest sense and on how they may be used.'[28]

North London offers an example. 93 acres of Thames Water land at Stoke Newington include filter beds and two reservoirs, a site identified as of national importance for wildfowl and as a major recreational amenity for (lest anyone forgets) local people with little other than streets to walk. Only huge public protest has led Thames to modify its industrial development plans for the site.[29]

Wilderness areas owned by water authorities face a different threat. Soon we may have to pay to walk in the Peak or Lake District. We pay to drive over the Severn Bridge, don't we? So what's the problem? What does it matter if public access rights hard-won over a century or more vanish like morning dew? To Michael Dower, National Park Officer for the Peak National Park, it does matter. He believes the Water Bill needs amendment to protect public interests. His once-good relationship with WAs is changing. 'We're afraid that their tune will change sharply after privatisation,' he says. Already he sees a tougher attitude on the part of North West Water, owner of 14,000 acres of the Longdendale Valley. When a club backed by the NWW applied to build a £1.5 million watersports centre on a Longdendale lake in 1988, the Park Authority denied permission. Yet Michael Dower feels besieged by changing attitudes. He fears the loss of negotiated public access rights to water authority land, recreational spoliation such as chalet development, the abandonment of good land management for the sake of maximised profits, and the sale of land to bidders like subsidised conifer forestry interests with whom conservation groups cannot compete.[30]

Similar worries are expressed by John Toothill, his colleague in the Lake District National Park, where North West Water owns vast catchments round Thirlmere and Haweswater (home to England's only nesting pair of golden eagles). So do climbers and walkers who fear soon they'll have to pay the water company to enjoy even those areas designated as National Parks or SSSI. Already, the Council for the Protection of Rural England says, the Lake District sees mounting numbers of commercial developments allowed on appeal.[31] 'We are very concerned that such large areas of beautiful landscape are to receive no special protection,' says Dame Jennifer Jenkins, chairwoman of the National Trust, adding that the Bill's

authors seem to have given no thought to the need for sympathetic upland management. 'Few people realise that privatisation will gradually lead to the degradation of the landscape.'[32]

The Countryside Commissioin worries not only about formally protected sites, but about those that remain unprotected. The Elan Valley reservoirs in mid-Wales have supplied Birmingham since the 1890s. Nantgwyllt, a house where Shelley briefly lived, is long lost under the waters of the valley's dark Garreg Dhu reservoir. Just a decade ago plans to develop the Craig Goch reservoir at the top of this wild valley into Europe's largest inland lake were dropped due to industrial recession and lack of projected demand. (Instead, Kielder Water in the North Tyne valley took the crown; built by Northumbrian Water at a cost of £167 million and opened in 1982, it holds 44,000 million gallons — all unused.)[33] Residents in the Wye Valley below were relieved. Now, though they need no longer fear a huge dam above them, they face exclusion from a vast region of open moor, eal for plantation of the alien conifer which already has ruined much other UK scenery, quite apart from the harm it does to l, water levels, and wildlife. Scotland, though as yet ntouched by the privatisation of water, already knows too well what harm is done to the land and to freedom of movement by such indiscriminate government-supported private development.

Recreation

People seeking recreation create a demand which privatised companies, free to explore their resources in a way that public companies cannot, will inevitably exploit. Some consequences of increased recreational development on the water and banks of reservoirs have been dealt with. Wildlife can be disturbed or driven away, the water rendered turbid or polluted, plant-life destroyed. Many reservoirs provide refuge and breeding ground for flora and fauna already harried into near-extinction. If market values are enforced not only on the city street but on such wild places that remain, then soon we may be left with no more than video records of what we've destroyed and lost.

Reservoirs already provide many leisure activities like game and coarse fishing, sailing, sail-boarding and bird-watching. Water authority land hosts picnic sites, nature reserves, footpaths and viewing points. There's no harm in this, given proper regulation and respect for nature. Indeed, a statutory water

authority responsibility as given by the 1973 Water Act is to provide water-based recreation.[34] But privatisation will encourage WUPLCs to shift exploitation of resources away from traditional sports like angling to new growth areas like theme parks. They may also be tempted to extend paid recreation to land and water assets actively used in water supply, thus threatening water quality and leading to environmental degradation. This danger is considerable, given the growing tendency to involve third parties in managing such activities, a tendency likely to increase conflict between developers and conservationists. In 1987 Anglian Water sold fishing rights on Rutland Water (designated an SSSI (Site of Special Scientific Interest) due to its international importance to wintering wildfowl) on a nine-year lease to a private management company, having already extended the permissible fishing period into winter without seeking Nature Conservancy Council consent. The NCC objected. Anglian Water threatened action on commercial grounds that the NCC was seeking to 'undermine the viability of the fishing and the sale of rights'.[35]

Planning authorities will be under increasing pressure to permit such profitable but ecologically damaging development. Mr Michael Howard says that the planning system will prevent such damage, and that the only developments likely in National Parks are those deemed to be in the public interest. Maybe. But the cases so far of development on Rutland Water, in Stoke Newington, and in the Lake District are not encouraging. In addition, leasing rights of access to water or land areas to clubs asking high membership fees will restrict public access and mask management responsibility for environmental degradation, while intensified use must inevitably increase the risk of drinking water pollution.[36] Who wants to drink water in which others have been splashing, windsurfing and maybe even powerboating? Will WUPLCs be liable for pollution by third parties?

We need rural recreation. But on what terms? Who values a policy that increases consumer cost while threatening not only our access to wilderness but the very existence of flower and tree, otter, diver, dipper and heron. If you know the answer, tell it to the birds — if you see any amid the sprouting chalets. Unlike them, we have the power to change, preserve, or destroy the environment of this small and vulnerable isle.

Sewerage and pollution control

Who wants to look down the drain? We prefer someone else to deal with our waste. But reluctance to deal with it extends to those in charge of it. 'Where there's muck there's brass'; this cliché suggests a robust outlook. Yet fifteen years after reorganisation, the Yorkshire Water Authority, with more sewer collapses than any other, doesn't even know where a third of its sewers lie. In Bradford, so many human faeces are found in the River Beck after heavy rain that locally they're called Barnsley Trout. The Beck can flood office basements and pedestrian subways. The cost of replacing 100 sewage storm outflows in Bradford alone is estimated as £40 million. Rats thrive. Likewise hardy bathers in the Mersey emerge from the water dirtier than they went in.[37] The authorities claim they're not to blame. They say they inherited an outdated network which since has received insufficient funding.

When in December 1988 Mr Ridley submitted an estimate of £1 billion to bring sewage works in the United Kingdom within EEC law by 1992, he neglected to mention the problem of storm overflows, the national repair of which is likely to cost a minimum £637 million, unless we all want faeces, tampons and the rest of it floating past us as we picnic on the bank. He didn't mention this extra cost because, though discharge of sub-standard sewage from a treatment works is illegal, storm overflow of raw human faeces is not.[38] The true cost involved in keeping sewage off beaches and out of rivers and sea is just not known. 'We can't be firm about the figures,' admit Department of the Environment officials, with regard to the repair and replacement of overflows. 'Only the water authorities really know how much it will cost.'[39]

Will it turn out much higher than current estimates? What formula will be found to raise cash to do the needed work while still generating profit? Will cheap options, involving more non-compliance with EEC law, be sought? What use is a stockholder's dividend if sewage still floats in the river past his picture window? Is individual profit a higher good than a healthy society? The Victorians knew that efficient sewage treatment and disposal, though generating no direct profit, represented a classic case of 'public good'. That's why they invested so much money, time and care in building sewage systems that worked so well that even now we still rely on their legacy. But Victorian systems are falling apart. So far we're not

doing enough to repair, let alone replace them. Formal estimates suggest that after privatisation WUPLCs will face at least two years of investment to improve sewerage (estimated cost: £1.5 billion); river (£1.5 billion); and beach quality (£1 billion). Theoretically these improvements will be paid for by permitted price rises under the RPI-X formula (see page 142). Yet as such investment will not enhance revenue, the utilities will be tempted both to overstate capital needs and to delay investment, leaving it to the NRA to ensure compliance by monitoring discharges.[40] Mr Ridley has already encouraged such an attitude by inviting the WAs to apply for exemptions from sewerage pollution consents in the run-up to privatisation.

Agricultural pollution

Will WUPLCs accept responsibility for the run-off of fertilisers, pesticides, silage liquor and slurry into public water? Why should they? They are not the polluters. Publicly they endorse the formula that the polluter pays. To date this has led to few prosecutions, for reasons stated earlier. In France the polluter does pay. The dirtier the effluent that factory, farm, or local authority produces, the more it pays in tax. Why not here? Industrial pollution is not usually too hard to trace back to source. Specific chemicals relate to specific types of enterprise. In agriculture, silage and slurry spills can usually be traced to a particular farm. But incidents of fertiliser pollution can be much harder to crack. Nitrate fertilisers in particular may have been leaching into the soil for years and travelling miles before entering the water system. How can you make the polluter pay when (a) you can't be sure who he is, and (b) when he might have been dead for thirty years?

De-nitrification processes are costly. One solution would be to tax the agricultural industry as a whole to pay for de-nitrification — though doubtless this would lead to a more expensive packet of Weetabix. Anglian Water estimate that to install de-nitrification plants to deal with their severe regional problem will cost £60-70 million over the next ten years and increase the cost of water supply by some 10–27 per cent.[41]

But again, as with sewerage, such investment is unlikely to generate profit and there will be an inbuilt tendency by WUPLCs (as with farmers) to talk down or deny the scale of the problem. The EEC has set a standard for the maximum permitted concentration of nitrates in drinking water; the British

government still denies that this standard is justified. Nitrate applications to grassland rose from 33 kg per hectare in 1963 to 230 kg per hectare in 1987.[42] If present nitrate levels in water result from application 30 years ago, what levels will we see in 2020? What mechanism does the Bill offer to deal with the arrival or increase of such problems in the future?

De-nitrification involves another form of investment in maintaining or upgrading environmental standards. Yet in that it relates to the service of water supply and not abstraction or quality, the local authorities and not the NRA will enforce standards. The obligation to obey EEC directives on nitrate levels will be taken into account when fixing allowable price rises under the RPI-X formula. A fixed rate of return will be permitted on the investment, offering a degree of profit so that, as with sewerage, the price paid by the consumer will be greater than under public ownership. Where no de-nitrification investment is now required, but may be in future due to nitrates still percolating through into water, no RPI-X investment would be permitted. In this case, with the increased cost of making potable the water from the licensed source, the value of the NRA's licence would fall. The Bill suggests no machinery for renegotiating the terms of abstraction licences save in relation to abstraction volume.

In fact in this area, as with other aspects of water privatisation, it grows more apparent every day that ideological insistence has been allowed to overwhelm practical planning and common sense.

SUMMARY

At present (March 1989) the government's plans for water privatisation are in such a shambles and so universally disliked that they may yet have to be postponed or called off — for the second time. Alarm at this possibility has already led Mrs Thatcher to attack her environment ministers in public.

'I know that the subject of privatisation hasn't been handled well or accurately,' she lately told Conservative local councillors, thus openly blaming her ministers for the unpopularity of the scheme.[43] And not just her ministers. The media too is in hot water, blamed for tarnishing the image of the water industry by publicising reports of rising charges and increased pollution. Is there an element of panic here? Mrs Thatcher and her ministers

flatly deny having second thoughts about going ahead with the sale.[44] Meanwhile, with the remaining stages of the Water Bill yet to be debated in the Commons before the measure moves to the upper house, meetings between officials for the United Kingdom and the EEC have already led to alterations in the Bill, including much stronger powers of regulation. Originally the idea was to give the WUPLCs substantial legal protection against complaints, and considerable latitude in removing poisons from their supplies. The changes will inevitably decrease water's attraction to private investors.[45] And as Mrs Thatcher moves to take personal charge of the troubled scheme, SDP leader David Owen dubs her 'Madame Perrier', in reference to French water firms making takeover bids for British water companies. 'At least our Victorian predecessors knew the values of pure water, publicly provided,' Dr Owen told his party's Scottish conference in Ayr, adding that 'the government's refusal to implement European standards on drinking water shows a contempt for water quality and the health of our people.'[46]

Quite so. As things stand now it remains to be seen if the sale of the English and Welsh water authorities proceeds as planned. But whether it does or it doesn't, the necessity for the great clean-up will still remain. And that will take years.

CONCLUSION: THE DANGERS OF COMPLACENCE

A factor common to many issues described in this book is the seeming complacency routinely displayed in public by government ministers with regard to water and environmental quality in Britain.

Whether privately they are as complacent is another matter. Yet the British record on the regulation or banning of dangerous chemicals, the clean-up of polluted rivers and beaches, the improvement of water quality and sewage treatment facilities, and the use of land and sea as a tip, has been so poor as to make one wonder why. Is it simply a matter of economic convenience? Of the present government, only Mr William Waldegrave has shown long-term concern for environmental quality. Yet he is not the environment minister. As for the recent apparent greening of the Tories, maybe it's best to wait and see if the conversion is real. The record to date is not encouraging. Time and again, on issue after issue, no action has been taken, or has been taken — often due to EEC pressure — grudgingly, slightly, and late.

But official apathy only mirrors public apathy. So long as no public alarm was sounded, the government did little. Now, with alarm over water, health and environmental issues daily growing greater, the government at last stirs itself to wear a green mantle, though it hardly sits easily on those who claim that the profit motive and market forces alone can guarantee public health and clean water. So can we blame the government for its laissez-faire approach when our own communal attitude has been, until recently, barely less lethargic, despite the growing body of evidence that people are being harmed — in some cases, chronically — by substances such as lead, alum, fluoride, pesticides, fertilisers and sewage-borne bacteria, which are present in our water as a result of deliberate policy, apathy, greed, or negligence?

Nor can we simply blame the water authorities for our doubts

as to the quality of what flows through our taps. On the whole, it is clear, they do their best. As for the high level of illegal sewage discharges, government cash restrictions during the last decade have made it hard for authorities to invest in repair, new plant, or alternative techniques of disposal. And despite the growing concern of many people, it is true that most of the water supplied in this country remains perfectly potable, and that treatment efficiently removes the most dangerous bacteria. Once again, when did you last meet someone dying of typhus or cholera?

Totally safe water supply cannot be guaranteed. Removing nitrates in particular is expensive and difficult. Contamination due to faults in the supply-line between treatment plant and domestic consumer is hard to deal with, save by adding chlorine or chloramines. Likewise it is difficult, given the huge increase in agricultural and industrial use of chemicals, to guard against or even to test for the subtle presence in water of some of these toxins. Even were the money made available, the tests required to isolate such substances would still remain time-consuming and complex. Even where such tests prove positive, it is difficult even for a well-funded agency to prevail over the powerful sectarian and vested interests that entrenched industries and agriculture represent.

Yet none of this excuses the complacency that so often pervades official statements in reaction to the recent growth in public concern. In cases like those of Lindane or Dieldrin, we still tolerate the use of chemicals which are tightly controlled or long banned elsewhere, as hazards to the environment and our health. Yet rather than admit the error and ban such toxins immediately and totally, officialdom still resorts to the unanswered letter, the promise to 'look into it', the soothing statement that there's nothing to worry about and that our water is the best in the world.

Such an attitude is dangerous, to say the least. Ultimately it is up to us all to see that it changes. 'The major responsibility for bringing you safe drinking water rests ultimately with yourself,' states a recent United States Environmental Protection Agency pamphlet. Maybe so. But how can this responsibility be exercised save by action to guarantee that water supplied via public systems (whether privatised or nationalised) is properly regulated and administered by independent bodies without personal financial interest at stake? Do we want a situation of chaotic individualism where every household has to invest, as best it

may, in its own water purification system? This is clearly a non-starter.

The individual financial profit motive alone too easily sabotages the conscience and clear thinking of all but the best of us. But there are other kinds of profit motive, of a sort apparently undreamed of by present ruling philosophy. For example, inculcation of the notion that the good of the many profits the good of each. Put another way, what's the good of being a millionaire if you're living in a world turned into a toxic mire? Where will you go to enjoy your wealth? Mars? Millionaires are stuck on this world, like the rest of us.

It seems clear: we need to re-invent the idea of 'public good'. Without public-spirited regulation, accidents like that which befell Camelford in 1988 can happen to any of us at any time. Our survival and good health is always contingent on factors and forces beyond personal control. Primitive civilisations tried to placate these forces by magic means. Today, we try to control them by scientific means.

Yet our control remains tenuous, to say the least. Disasters like Camelford are the dramatic, visible, immediate aspect of continuing processes that rarely show themselves so clearly. More often such health crises develop invisibly, undramatically, but chronically, over months and years. The tendency is to laugh them off until it's too late. Gin-and-alum, anyone? Or whisky-and-nitrate? Or a bath in H_2O that's rich in sewage effluent and the trace elements of hundreds of different industrial chemicals?

Recent months provide sufficient examples of a serious lack of control in the handling of dangerous substances which can easily invade waterways — casual disposal of hazardous wastes, leaks of Lindane, ammonia spillages, the legal disposal of substances like cyanide in rivers, ignorance and lack of research into the long-term effects of pesticide pollution, the increasing invasion of water by slurry and silage effluents. And though it may well be that hard-pressed authorities are in many cases doing their best to stem the rising tide of such pollution, sadly their best is not good enough. How can it be, when they are not only financially constrained and subject to political whim, but legally limited by lack of effective law and by the unwillingness of many magistrates to fine polluters up to the hilt?

Moreover, those in authority are as fallible and often as ignorant as the rest of us. They are human beings, after all.

Ultimately it *is* up to us. We can't know what's coming out of our tap if we don't find out. If we don't find out, we can't do anything about it. What do we do when we learn too late that *because* we've done nothing about it, there is nothing we *can* do about it. Except SWALLOW it. Literally.

It's useless to blame others for a system that isn't perfect. The best we can do is to arm ourselves with knowledge and wake up to the fact that, like it or not, we are embarking on a new era. The old-style politics of Left and Right are irrelevant now. It's no longer about socialism vs capitalism. It's about global survival.

Does this sound too melodramatic? If so, that's only because we've so long taken safe drinking water (and so much else) for granted that we're slow to wake up to the scale of the crisis, here in Britain as elsewhere.

Part of the problem is that we tend to see the world in terms of what we already know, or think we know. An imaginative reassessment of all our options is needed. Received knowledge is old knowledge. When times change as fast as they do now, old knowledge can kill. We live in the past, in supermarket-two-car-family tradition even as we fatally alter the present by our manipulation of the environment and its resources. It seems only when directly affected — when our tapwater is flooded by alum, or our river by Lindane or raw sewage — do we even begin to see that there *is* a crisis.

In 1985, citizens of the United States, living amid a vast landmass, with a population density over twenty times lower than Britain's, spent over $800 billion on water-purifying products, especially those based on activated carbon. This raises interesting questions. Are public water supplies in the United States so much worse than those in the United Kingdom? After all, many modern water treatment processes were pioneered in the United States. Or is it that American citizens en masse are more aware of the potential health hazards of polluted water? So, American society epitomises the working of 'market forces'. But more public money per head is spent on health care in the USA than is spent in Britain today. So it's not just a question of American citizens investing in domestic protection purely as a reaction to a political perception that the state doesn't care about their health.

So who's fooling who? Are we so sure our water is superior to American water, or that United States citizens are wrong about the dangers to their health, or that they are simply suckers for

advertising? Likewise: do we really believe the government line that EEC standards over water quality are needlessly strict, when clearly this line is taken simply to avoid the responsibility of public expenditure? Do we really think of water pollution as something we can do nothing about, or as a problem safely given over to 'market forces'?

Once again: private or public ownership as such is not the real issue. What we need is responsible regulation, and planning for the future that takes long-term social gain, not just short-term individual profit, into account. What we need is a commitment, from top to bottom, to clear up the mess. Companies who knowingly or negligently dump deadly toxins into common waters attack us all. Supervisory bodies, whether private or public, are useless if they have no teeth, if they never use their powers to prosecute. Fine slogans like 'the polluter pays' are just sick jokes if the polluter never does pay, or pays only such fines as lighten his wallet fractionally.

Stronger measures are needed — measures that bite.

They will have to bite not only those who directly pollute, but all of us. Polluting companies (except for specialised cases, like the nuclear industry) cannot exist (make profit) if the rest of us don't buy their products. In the case of monopoly industries, such as electricity and coal, the problem is obviously more difficult. Higher prices in many areas seem unavoidable. However, it seems odd that such higher prices should be escalated even more by an artificial insistence on generating stockholder profit at the expense of non-stockholding consumers. That is simply to penalise the many for the pleasures of the few.

Meanwhile, increasing numbers of Britons, though slow to see the necessity (if that is what it is), have begun to invest in one form or another of domestic water purification. There are a growing number of products that claim to treat tap-water efficiently (see Appendix A). Should they be necessary? In an ideal world, no. Whether we receive water from nationalised RWAs or privatised WUPLCs, no water should come through our taps so dubious in quality that we fear to use it without spending money (which many of us cannot afford) on purification additional to that supposed to have been carried out already. Why else do we pay water charges — charges which, it is clear, are due to go up dramatically?

The fact is, however, that more people every year in Britain decide that some form of domestic water purification system *is*

necessary. That in itself is unarguable. In which case, the important thing is to work out and lay down a national code of conduct and minimum safety levels to govern such equipment as is sold for domestic purposes. To date, such a code does not exist in the United Kingdom.

Finally, water pollution, and the illnesses arising from it, is by no means inevitable. It can be eliminated given more regard for water as a natural resource; better knowledge of its limited capacity to sustain our demands on it; and, above all, better self-education as to how we are letting our environment, our wealth, and our children's health, be blighted. How can we be so complacent with our lives at stake? What will we tell our children when they ask; 'Why didn't you do something about it?'?

In other words: 'What did *you* do in the environmental War, Daddy?'

POSTSCRIPT

Today, 5 June, is World Environment Day. Hardly as well-known in Britain as Christmas or Easter or Guy Fawkes Day, is it?

It's two months since I finished writing this book. The forthcoming water sale staggers on from crisis to crisis. Whether by the time you read this the sale will still be on is anyone's guess. At present it looks like a lead balloon, recent reports on lead in British drinking water being among the major factors currently embarrassing the government. With the European Commission pressing the United Kingdom to comply with European water directives by the end of the year or face prosecution, the cost of meeting those standards with regard to lead pipe replacement all over the country could amount to 'a number of billions of pounds', says Jonathan Kent, water analyst for City stockbroker Flemings.[1] The industry itself estimates that it may cost an average of £500 per household to replace lead pipes, the supplier being responsible for replacing all piping that runs from the mains to property boundaries.

The Water Bill has also run into other obstacles of a kind unlikely to encourage investors. The clause which would have exempted the newly-privatised water utilities from prosecution by consumers has been dropped following EEC pressure. On 15 May the government was defeated by 81 votes to 47 during the Bill's committee stage; the peers approved a Labour amendment seeking to impose a deadline on the government to meet EEC water purity standards by 1 September 1993.[2] The conservation lobby too has new cause for hope, a clause having been introduced to the Bill requiring private companies taking over water authority assets to inform National Park Authorities before making any significant changes to the landscape. Even so, the park authorities will have no veto, and it remains likely that private developers will retain the whiphand under the new scenario. But the fight is not over. Commons amendments have been introduced to protect the public's 'right to roam' on water company land, with special reference to Thirlmere and Haweswater in Cumbria, and to the Elan Valley in Mid Wales.[3]

Meanwhile in-fighting between government departments con-

tinues to suggest that there is no united front on this issue round the Cabinet table. Mr Ridley is at last converted to the notion — forced on him by EC Environment Commissioner Signor Carlo Ripa di Meana — that some of the proceeds of the £7 billion sale should go not into the Treasury but back to the industry, to help clean up our rivers and beaches. Then who should come along to put a spike through the bows of this notion but the Chancellor, Mr Nigel Lawson! For Mr Lawson and his officials are said to fear setting such a precedent, especially with further privatisations to come.[4]

It all begins to look like 1989's version of a Gilbert and Sullivan comic opera . . . quite as absurd, if not so funny. Because amid all this squabbling alarming incidents continue to occur. Incredibly, and less than a year since the Camelford accident, South West Water has done it again. Despite the findings of its own report into the Camelford incident, on 16 May the authority spilled 500 gallons of aluminium sulphate into a tributary of the River Torridge near Bideford in north Devon, though this time, luckily, without the same dire effects that attended the original disaster. Leaking into the river while being transferred from a main tank to a mobile tanker via a pipeline, the alum killed only a few fish over a 1,000-yard stretch.[5] Nonetheless, this repeated act of incompetence (blamed on 'human error' by an authority spokesman) does little to suggest that the government has its sights set on the right sort of target, any more than does the Department of the Environment's policy of inviting the authorities to apply for relaxation of sewage disposal standards, so as not to deter investors over the risk that the privatised companies might be prosecuted for failing to meet the standards.

The Department of the Environment has stated that this relaxation is temporary only, and that it intends to have all sewage plants brought up to *existing* standards by 1992. *ENDS*, the environmental journal, claims that as many as 2,300 sewage plants may be eligible for relaxed standards, and recently expressed doubts that all the applications can be processed by November, the date set for the flotation.[6] So that again we face a situation in which the government's zeal to privatise has apparently blinded it to the more pressing issues of public health and utility. For, whether privately or publicly owned, what the water industry surely requires from government is not more political contention, but common sense. Is private (or public) ownership

really more important than the development of more efficient management and treatment techniques to guarantee public health? Instead of wasting vast sums of money (from our pockets) on a bewildering national advertising campaign to sell water like Coca-Cola, surely it would make more sense for our elected representatives to attack the crisis at source by spending these millions on a co-ordinated and national drive to improve our water treatment and sewerage facilities.

As things stand, we inhabit a Maggie-in-Wonderland scenario in which, the more topsy-turvy a policy is seen to be, the more sacred it becomes; a Wonderland in which resistance to such a policy is seen only as justifying it. It's a scenario as absurd as anything Lewis Carroll imagined. Without the evidence confronting us now, who would have believed that reality could so easily come to match the illogic of the Mad Hatter's Tea Party?

Water, water everywhere, and all of it up for grabs. And now to end this as I began: late last night, as I walked by the Moray Firth, again the scum was being washed up onto the sand. Meanwhile Highland Region's water and sewage department at Inverness means to go ahead with the construction of a sewage outfall pipe, 1.5 km long, to dump the city's macerated but untreated sewage into the Firth close to its narrowest and most landlocked point, where the water is only 10 metres deep. The department believes that the tide will carry the sewage out to sea. The Scottish Secretary has already approved this plan as 'economic and effective', and has refused demands to call in the application for reconsideration.[7]

Meanwhile, no official protection is to be extended to the Moray Firth's dolphins, one of only two resident groups remaining in Britain. And no, I have not seen any dolphins in the Firth since the summer of 1988.

Perhaps they've packed their bags and emigrated. If so, we wish them better luck in cleaner seas elsewhere — if they can find them.

AN ABC OF DOMESTIC WATER PURIFICATION

What follows outlines common domestic water problems and some of the processes used to treat them, but does not endorse any technique or product range. You should seek expert advice before installing any water treatment product. Remember: the United Kingdom still has no clear guidelines to guarantee minimum safety standards. Water Research Centre certificates relate to the mechanical efficiency of water treatment equipment; they do not guarantee that such equipment does what is claimed for it. Some devices available may in themselves create a health hazard, so beware of 'cowboy' products cashing in on scares over water quality. Some addresses of UK importers or manufacturers of domestic water treatment equipment are listed at the end of this section. They consist of companies who answered my requests for information. I do not assess or compare their products.

Acid water. A growing problem due to acid rain. But water may be naturally acid. On falling through the air, rain absorbs carbon dioxide. On reaching the earth it absorbs more if flowing through decaying vegetation. If it then passes through rock such as granite, the carbonic acid remains unneutralised. Such water can seriously corrode a plumbing system, especially if low in mineral content and lacking alkaline salts to buffer the carbonic acid.

Treatment. Most simply, to pass the water through a tank containing limestone chips, which react with the carbonic acid to produce calcium bicarbonate. Where high carbon dioxide concentrations exist, a solution of soda ash (sodium carbonate — Na_2CO_3) may be fed into the water. This should be done before the water meets any tank or mixing device, to create consistent

concentrations in the water to be treated. Most domestic pressure tanks are adequate for this.

Alkalinity. May be due to the presence of one or more of a number of ions. These include hydroxides, carbonates, and bicarbonates. The latter are the most common source of alkalinity, being found in almost all natural water supplies. Moderate alkaline concentrations are desirable in most supplies to balance out the corrosive effects of acidity, but an excess may cause an objectionable 'soda' taste, while highly mineralised alkaline waters dry the skin by removing normal skin oils.

Treatment. No removal techniques are really satisfactory for domestic needs. They include:

- *Ion exchange.* An anion resin regenerated with sodium chloride will remove most anions (carbonates, bicarbonates and sulphates), replacing these with a chemically equivalent amount of chloride ions — almost as undesirable as the original alkalinity.
- *Mineral acids* neutralise alkalinity. Hydrochloric acid, sulphuric acid, or a combination may be used, converting carbonates and bicarbonates into carbonic acid. It is advisable to provide a way to let the gas escape into the atmosphere, while caution is required in handling the strong acid. Again, get good advice before undertaking such a process.

Bottled water. Not really a safe alternative. Germs and algae can bubble into the water from the surrounding air as the water is drawn. Coliform bacteria may be present, indicating the potential presence of harmful organisms. In Britain, much of what passes as 'natural' or 'spring' water in bottles may be nothing of the sort. Discrepancies may be found between actual content and that stated or implied on the label. Caveat emptor.

Ceramic water conditioners (also known as **magnetic conditioners**). These provide an alternative to conventional water softeners that rely on sodium-salt interchange (see *hard water* and *zeolite water softeners*). Ceramic conditioners employ magnets to descale and prevent corrosion. No chemicals are

involved. Health and maintenance problems connected with sodium intake are avoided.

Process. At the core of this system is a high concentrated permanently charged energy inducer made of ceramic ferrite material, most often fitted to the rising main just above the first stop valve. Mounted outside the pipe, the ceramic ferrite blocks cannot become coated by water residues. When the tap water passes through this energised chamber, the dissolved minerals in it (calcium and magnesium carbonates) are affected so as to resist scale formation. The conditioner operates by reducing the 'adhesive bond' between these dissolved solids and the plumbing equipment. There are no maintenance costs, and the conditioners are reckoned to lose no more than 0.01 of their magnetic strength per annum. But be sure that the conditioner you buy is for domestic use. There are many commercial models which may work well only in continuous-flow situations.

Distillation is effective against nitrates, bacteria, chlorine, dissolved minerals and trace elements, but not against all chemicals. A distiller big enough to purify the amount of water used daily by the average family would be costly to run. Such units also waste a lot of water and take up valuable space.

Process. Water is heated to steam. Steam vapour passes over coils and condensers to provide drinking water. Most volatile gasses pass out of the system, from which the heavy contaminants are also flushed. Non-volatile mineral salts remain in the distilling vessel. The purity of the distilled water depends on many factors — composition of the minerals initially present, the design fo the device, and the degree of protection from contamination provided for the distillate. Superior devices have water or water-contacting surfaces of tin. The best are made of quartz. Most domestic devices are made of stainless steel.

Format. Sink-mounted or remote installation in cabinet styles. Different manufacturers offer various safety features. Gas, electric, or alternative energy models are available.

Problems. Distilled, demineralised water is not considered a good beverage by the United States Environmental Protection Agency, being described as tasteless, flat, or sometimes bitter. Prolonged consumption may harm health. There seems to be a correlation between consuming soft water (distilled water is very soft) and incidence of heart disease. Distilled water is also very 'aggressive' and will dissolve many metals. Due to the inability

of such systems to remove organic chemicals, many manufacturers are now adding some form of carbon filtration to their equipment.

Granular activated carbon filters (GAC). In one form or another, these are the most commonly used filters for domestic purification. If properly maintained (the filters should be changed at least monthly to prevent the growth of opportunistic bacteria), GAC filters absorb odour and chlorine compounds. It is also claimed that they remove many other contaminants; pesticides, heavy metals, bacteria and nitrates. This may be true when GAC is used in controlled conditions and subject to constant monitoring.However the efficiency and safety of GAC in the domestic context remains controversial.

Process. GAC filters operate by a physical, not chemical or biological, process known as adsorption. The carbon granules (each with an extensive internal network of pores forming a large surface area) in the filter trap and hold organic molecules in the water passing through. The quality of water discharged depends upon the amount of carbon, the depth of the column through which the water passes, and the rate of flow of the water. The longer the contact time,the cleaner the water. But algae, mildew and other types of muck will gradually collect and form on the carbon, requiring regular backwashing or exchange of the filter cartridge to avoid contamination.

Format. Whole house units, counter-top or under-sink models are available.

Problems. The moist, enclosed body of carbon provides an ideal environment for opportunistic bacteria. Their growth can be so fast that in just a few weeks a GAC filter can start passing on water containing bacteria at levels up to a thousand times higher than exist in the supply being filtered. A healthy adult is unlikely to be harmed by such bacterial levels, but the same is not necessarily true in the case of the very young or old, in whom GAC filtered water has caused serious stomach and bowel complaints. Anyone using a GAC filter should change the cartridge at least once a month, or purchase a model possessing not only a reliable backwash facility but so designed that contaminants are not trapped between the filter elements.

Hard water. 'Hardness' in water means the total of all dissolved calcium, magnesium, iron and other heavy metal salts

which typically impair the efficiency of soaps and detergents. Hardness is expressed in grains per gallon, milligrams per litres, or parts per million as if all such salts were present as calcium carbonate. Other than by treatment processes mentioned elsewhere, hardness may be removed by lime-soda softening; or in internal boilers by employing inorganic salts like phosphate or carbonate along with protective or reactive organic materials. In internal cooling water treatment processes, hardness can be controlled by using organic and inorganic surface active agents in conjunction with acids like sulphuric acid. Hardness is thus retained in solution and its precipitation as scale prevented.

Though hard water will not lather, for drinking purposes it is much better for the health than soft or aggressive water.

Iron filters. Iron problems are complex. No iron filter should be installed without expert advice. They remove precipitated and dissolved iron (and manganese compounds) from raw water supplies, and may be used either in gravity-fed or pressurised water treatment systems. In most common ground waters the dissolved iron is found in the ferrous bi-carbonate state due to the presence of free carbon dioxide. In this state the iron compound cannot be filtered, because it remains in solution as a compound. But there are filters which, acting as a catalyst between the oxygen and the soluble iron compounds, produce ferric hydroxide which precipitates and may thus be filtered easily.

Jug filters. These, now popular in Britain, are not a practical means of providing drinking and cooking water for the entire family, but do fulfil a need, especially for people unable to afford or unsure of the quality of more complex, expensive systems. One make, the Brita filter, has been recommended by Thames Water to consumers in its area who dislike the taste of chlorine, or who are unsure of the potability of their tap water.

Reverse osmosis. This expensive process has been installed in the homes of people on kidney dialysis to remove aluminium from their water. It removes bacteria, minerals and trace elements, and will annul nitrates, aluminium, sodium, chlorine and its compounds like THMs.

Process. Water is forced by pressure through a semi-permeable membrane. Dissolved and particulate materials are left behind. When pressure is applied to the concentrated

solution, water is forced through the membrane from the concentrated to the dilute side. There are different types of membrane each requiring specific and critical water influent standards. The membrane should be replaced annually. Such a system operates on 40–60 psi or with an additional pump accessory. When ordering, the membrane should be specified for chlorinated water, non-chlorinated water, or either.

Problems. Reverse osmosis is very costly and wastes approximately 20 parts of water to each part purified. Excessive pressure tends to deform or compact the membrane, causing it to become less porous, thus decreasing still further the amount of product. Bacteria, if allowed to grow on the membrane,will digest the top layer and reduce the membrane's ability to reject salt. Fouling or surface coating is thus a common problem, due to salt precipitation. Temperatures above 98°F are undesirable, due to accelerated compaction and hydrolysis rates. Due to an inability to remove organic chemicals, many manufacturers of reverse osmosis equipment are adding carbon filtration to their equipment. As with distillation, a mineral-free water is produced, which may in the long term harm the health. The water is also usually very acid, so much so that it may corrode pipes and taps.

Sediment filters. For cloudy, dirty, or turbid water, evenly-graded silica or granite sand is the filter medium. Addition of a layer of garnet will increase filtration. Water containing colloidal or suspended matter may require pre-treatment with alum to aid coagulation of the sediment.

Silver-charcoal filters. Silver is widely used in activated carbon filters. Silver does kill bacteria, but so slowly that United States Environmental Protection Agency tests show it to be ineffective as a bacteriastat. Not only does silver fail to increase the unit's ability to remove impurities, bacterial or chemical, but it may also enter the water. In the United States, the Maximum Contaminant Level for silver has been set at 50 parts per billion — an exceedingly small amount. The level set is, in fact, as low as that for lead. Chronic silver intake leads to permanent discolouration of the skin, mucous membranes, and eyes.

Ultraviolet. Kills micro-organisms including bacteria, protozoa, moulds, yeasts, fungi, neotode eggs and algae, and provides water free of micro-organisms without the use of germi-

cidal chemicals, oxidants, algaecides or chemical precipitants.

Process. Low-pressure mercury lamps generate short-wave ultraviolet. A UV system consists of an aluminium or stainless steel enclosure housing lamps interspaced with teflon tubes through which water flows and is bombarded by the UV. The disinfecting mechanism is thought to involve disruption of the DNA and RNA cell replication system by breaking the chemical bonds which tie the individual elements and groups together. UV light can be used with an oxidant such as hydrogen peroxide. UV systems are initially expensive. Tube-life is approximately 1,000 hours. Otherwise operating costs are low. Thousands of gallons may be purified for each penny of cost.

Format. Under-sink, teflon tube or quartz models available, plus various optional safety control systems.

Status. UV-treated effluent will exceed any existing health standards for biological purity. The system operates without special attention or maintenance.

Applications. Ideal for social or industrial use where biologically pure water must be absolutely guaranteed — in hospitals and research laboratories; in breweries, soft drink and water-bottling plants; in the packaging of mass-marketed food; in safeguarding against spoilage of dairy products; in the production of pharmaceuticals and chemicals; in reducing pathogenic bacteria and viruses in wastewater effluents. There are no known harmful by-products.

Zeolite (and other) water softeners. Zeolite, a sodium compound known as an ion-exchanging material, is a traditional water-softener.

Process. When coming into contact with hard water, the zeolite exchanges the calcium and magnesium for sodium, forming sodium carbonates and sulphates, which are soluble and do not stop water lathering. In time all the sodium in the zeolite is replaced by calcium and magnesium from the hard water. The zeolite is renewed by flushing with sodium chloride, thus washing away the calcium and magnesium as chloride waste products.

Problems. The zeolite process does not remove sediment even though it appears to act like a filter. The resulting taste of the sodium-rich water may be objectionable, while long-term health hazards (especially for the elderly) can result from sodium intake — specifically, high blood pressure, fluid retention, and other disorders. Each half-gallon of this type of softened water

contains as much sodium as five slices of white bread.

Warning. ALL softened water, produced by whatever means, is bad for the health. Softened water should never be used for drinking or cooking. Water softeners should never be connected to drinking water supplies. However, soft water is safe to bathe in or to wash up with.

SUPPLIERS AND CONSULTANTS

Contact the following for detailed information about their product ranges, cost of installation, and running costs.

Aldous & Stamp Ltd produce and/or market a wide range of water treatment equipment and also offer technical advice and a mail order service from:
86-90 Avenue Road,
Beckenham
Kent BR3 4SA
01-659-1833/4/5

Aqualife Marketing Ltd distributes the extensive Rockett range of water filters, manufactured by the Rockland Corporation of Tulsa, Oklahoma, from:
12 Commercial Road
Buckie
Banffshire
Scotland
0542 32203

Citmart Ltd distributes the American Everpure range of filters which have passed every safety standard test in the USA and Canada.
Citmart Ltd
Ashford Airport
Hythe
Kent CT21 4LT
0303 62211

Cognosco Consultants Ltd distribute the domestic water treatment range manufactured by National Safety Associates, of Memphis Tennessee, from:
No. 1, 15 Station Road
Bath
Avon BA1 3DY
0225 28650

USEFUL ADDRESSES

BODIES CONCERNED WITH CONSERVATION AND THE ENVIRONMENT

Advisory Committee on Pollution of the Sea, (ACOPS)
3 Endsleigh Street
London WC1H 0DD
01 388 2117

British Trust for Conservation Volunteers (BTCV)
36 St Mary Street
Wallingford
Oxon OX10 0EU
0491 39646

British Trust for Ornithology
Beech Grove
Tring
Herts HP23 5NR
044 282 3461

Conservation Trust
George Palmer Site
Northumberland Avenue
Reading
Berks RG2 7PW
0734 868442

Consumers' Association
14 Buckingham Street
London WC2N 6DS
01-839-1222

Council for the Protection of Rural England
4 Hobart Place
London SW1W 0HY
01 235 9481

Countryside Commission
John Dower House
Crescent Place
Cheltenham
Glos GL50 3RA
0242 521381

Countryside Commission for Scotland
Battleby
Redgorton
Perth PH1 3EW
0378 27921

Friends of the Earth
26-28 Underwood Street
London N1 7JQ
01 490 1555

Friends of the Earth (Scotland)
15 Windsor Street
Edinburgh 7
031 557 3432

Green Party
10 Station Parade
Balham High Road
London SW12 7AZ
01 673 0045

Green Party (Scotland)
11 Forth Street
Edinburgh EH1 3LE
031 556 5160

Greenpeace
30-31 Islington Green
London N1 8XE
01 354 5100

Marine Conservation Society
4 Gloucester Road
Ross-on-Wye
Herefordshire
0989 66017

National Pure Water Association
Bank Farm
Aston Piggott
Westbury
Shrewsbury SY5 9HM
074 383 445

National Anti-Fluoridation Campaign
36 Station Road
Thames Ditton
Surrey KT7 0NS
01 398 2117

Nature Conservancy Council
Northminster House
Northminster Road
Peterborough
Cambs PE1 1UA
0733 40345

Nature Conservancy Council (Scotland)
12 Hope Terrace
Edinburgh EH9 2AS
031 447 4784

Ramblers' Association
1-5 Wandsworth Road
London SW8 2LJ
01 528 6878

Royal Society for Nature Conservation
The Green
Nettleham
Lincoln LN2 2NR
0522 752326

Royal Society for the Protection of Birds
The Lodge
Sandy
Bedfordshire SG19 2DL
0767 80551

Salmon & Trout Association
Fishmonger's Hall
London Bridge
London EC4R 9EL
01 283 5838

Scottish Society for the Prevention of Cruelty to Animals
19 Melville Street
Edinburgh 3
031 225 6418

Tree Council
35 Belgrave Square
London SW1X 8QN
01 235 8854

Worldwide Fund for Nature
Panda House
11-13 Oxford Road
Godalming
Surrey GU7 1QU
04868 20551

WATER USE – CONCERNED AGENCIES

British Effluent and Water Association
51 Castle Street
High Wycombe
Bucks HP13 6RN
0494 444544

British Waterways Board
Llanthony Warehouse
Gloucester Docks
Gloucester GL1 2EH
0452 25524

Scottish River Purification Boards Association
City Chambers
Glasgow G2 1DU
041 221 9600

Water Authorities Association
1 Queen Anne's Gate
London SW1 9BT
01 222 8111

Water Reasearch Centre
660 Ajax Avenue
Slough
Berks
0753 37277

REGIONAL WATER AUTHORITIES AND SERVICES

English & Welsh Regional Water Authorities

Anglian
Ambury House
Huntingdon PE18 6NZ
0480 56181

Northumbria
Northumbria House
Regent Centre
Gosforth
Newcastle-upon-Tyne NE3 3PX
091 284 3151

North West
Dawson House
Great Sankey
Warrington WAJ 3WN
092 572 4321

Severn-Trent
Abelson House
2297 Coventry Road
Sheldon
Birmingham B26 3PU
021 722 4000

Southern
Guildborne House
Worthing
Sussex BN11 1LD
0903 205252

South West
Peninsula House
Rydon Lane
Exeter EX2 7HR
0592 34136

Thames
Nugent House
Vastern Road
Reading RG1 8DB
0734 593333

Welsh
Cambrian Way
Brecon
Powys LD3 7HP
0874 3181

Wessex
Wessex House
Passage Street
Bristol BS2 0JQ
0272 290611

Yorkshire
West Riding House
67 Albion Street
Leeds LS1 5AA
0532 790031

Scottish Regional Councils

Borders
West Grove
Waverley Road
Melrose
0896 55113/2056

Central
St Ninian's Road
Stirling FK8 2HB
0786 62811/64213

Dumfries & Galloway
70 Terreagles Street
Dumfries DG2 9BB
0387 60756

Fife
Fife House
Glenrothes
0592 756541

Grampian
Woodhill House
Westbury Road
Aberdeen AB9 2LU
0224 682222, ext 2385

Highland
Regional Buildings
Glenurquhart Road
Inverness IV3 5NX
0463 234121

Lothian
6 Cockburn Street
Edinburgh EH1 1NZ
031 229 9292

Orkney
Council Offices
Kirkwall
Orkney KW15 1NY
0856 3535

Shetland Islands Council
Water Department
92 St Olaf Street
Lerwick
0595 3535

Strathclyde
419 Balmore Road
Glasgow G22 6NV
041 336 5333

Tayside
Bullion House
Invergowrie
Dundee
0382 562581

REFERENCES

INTRODUCTION: WE'RE ALL WETS

1. 'Sea of Troubles', Pat Sinclair, *Radio Times*, 31.12.88.
2. *Guardian*. 13.7.88.
3. *Guardian*. 13.6.88.
4. *Liquid Assets: the Likely Effects of Privatisation of the Water Authorities on Wildlife Habitate and Landscapes*, by Bowers,O'Donnell & Whatmore; a report commissioned by the Council for the Protection of Rural England, December 1988, p. 23.
5. ibid., p. 20.
6. Countryside Commission, news release, 10.1.89.

Water, Water Authorities Association booklet, 1985.
Guardian, 13.7.88.
Green Party newsletter.

WATER: THE BASICS

1. *Disease & History*, Frederick E. Cartwright, Mentor 1972, p. 152.
2. *Observer*, 20.4.86.
3. *Dreams of Dragons*, Lyall Watson, Sceptre 1987, pp. 122ff.
4. *Supernature*, Lyall Watson, Hodder & Stoughton 1973, p. 37.
5. *Dreams of Dragons*, op.cit., pp. 122ff.
6. *Botanic Man*, David Bellamy, Hamlyn 1978, p. 28ff.
7. *World Atlas of Shipping*, ed. W.D. Ewart, Philip & Son 1972.
8. *Future Weather*, John Gribbin, Pelican 1982, pp. 103ff.
9. *Man and Environment*, Robert Arvill, Pelican 1983, pp. 138ff.
10. *Water*, op. cit.

2. HISTORY: FROM CULT TO CHOLERA

1. *Timaeus & Critias*, Plato, trans. Desmond Lee, Pelican 1983.
2. *Woman's Mysteries*, Esther Harding, Rider & Co. 1971, p. 107.

3. *Of the Chaldean Kings*, Berossus (see *The Sirius Mystery*, Robert K.G. Temple,Sidgwick & Jackson 1976, Appendix II).
4. *Occidental Mythology*, Joseph Campbell, Penguin 1976, pp. 22-24.
5. 'The World's Last Mysteries', *Reader's Digest*, 1977, p. 143.
6. *Sacred Waters*, Janet & Colin Bord, Paladin 1986, p. 11.
7. *Disease in History*, Frederick F. Cartwright, Mentor 1971, pp. 15ff.
8. 'Awash with Science', Stephen Young, *New Scientist*, 24.12.88.
9. 'Fluoride, the "Smoking Gun" in Acid Rain', Gladys Caldwell, in *The American Sunbeam*, November 1982.
10. *Sacred Waters*, op.cit., p. 15.
11. *Supernature*, op. cit., p. 115.
12. *Earth Magic*, Francis Hitching, Picador 1977, p. 141.
13. *Welsh Christian Origins*, A.W.Wade-Evans, 1934.
14. *Earth Magic*, op.cit., p. 141.
15. *Disease in History*, op. cit., p.152.
16. ibid., pp. 154-8.
17. 'Britain's Water Rats', Part III, *Sunday Times*, 12.3.89.

3. WILDLIFE: FROM HIGHLAND TO SEA

1. *Daily Telegraph*, 7.3.89.
2. *The Conservation of Lakes*, Nature Conservancy Council 1983, p. 8.
3. *Observer*, 1.1.89.
4. 'Land Drainage and Birds in England and Wales', Gwyn Williams & J.K. Bowers, *RSPB Conservation Review 1987*, p. 25.
5. 'Interaction between wildfowl and recreation at Llangorse Lake and Talybont Reservoir', C.H. Tuite, Myrfyn Owen and David Painter, *Wildfowl* 34 (1983), pp. 48-63.
6. *Liquid Assets*, op. cit., p. 27.
7. *Sunday Times*, 26.2.89.
8. *Sunday Times*, 5.2.89.
9. *Sunday Times*, 5.3.89.
10. Memorandum and evidence submitted by the Royal Society for the Protection of Birds to House of Commons Environment Committee, 3rd Report on the Pollution of Rivers and Estuaries, HMSO 1988, p. 287.

11. *The Conservation of Rivers*, Nature Conservancy Council 1987, p. 7.
12. *Land Drainage and Birds in England and Wales*, op. cit., p. 26.
13. ibid., p. 26.
14. *The Conservation of Fens and Marshes*, Nature Conservancy Council, 1983, p. 6.
15. *The Conservation of Estuaries*, Nature Conservancy Council, 1983, p. 4.
16. RSPB memorandum, op. cit., p. 280.
17. *The North Sea*, BBC2 Scotland, 12.1.89
18. RSPB memorandum, op. cit., p. 280
19. *The Conservation of Estuaries*, p. 7.
20. RSPB memorandum, op. cit., p. 290.
21. *Points of View No. 7: Tidal Power Barrages*, Nature Conservancy Council.
22. RSPB memorandum, op. cit., p. 290.
23. ibid., pp. 284-5.

4. THE WATER INDUSTRY

1. *Man and Environment*, op. cit., pp. 158-9.
2. *Acid Rain*, Fred Pearce, Penguin 1987, pp. 73, 75.
3. *11th Annual Review*, Grampian Regional Council Department of Water Services, June 1986.
4. *Nitrates: A Needless Danger*, Fred Zahradnik, United States, 1983
5. *Nitrates*, Nature Conservancy Council pamphlet.
6. *Acid Rain*, Fred Pearce, op.cit., pp. 11ff.
7. 'Waterside wealth gives canals new life', Hugh Pearman, *Sunday Times*, 6.2.89.
8. *Liquid Assets*, op. cit., p. 22.
9. ibid., p. 109, *Daily Telegraph*, 6.2.88.
10. *Daily Telegraph*, 6.2.89.
11. *Independent*, 8.2.89.
12. ibid.
13. *Water*, op. cit.
14. *Man and Environment*, op. cit., p. 127.
15. 'Land, Land Everywhere', Charles Clover, *Daily Telegraph Weekend Magazine*, 14.1.89.
16. *Water Pollution from Farm Waste (1987 England and Wales)*, Water Authorities Association, April 1989.

17. *Sunday Times*, 5.3.89.
18. *Times*, 15.5.87.
19. *Sunday Times*, 14.2.89.
20. *Guardian*, 9.2.89.
21. *Financial Times*, 14.3.88.
22. *Liquid Assets*, op. cit., p. 32.
23. *Guardian*, 7.4.86.
24. 'Sins of Emission', Frances Craig, *She Magazine*, July 1988.
25. *Observer*, 18.9.88.
26. *Daily Mirror*, 25.11.88.
27. *Guardian*, 13.7.88.
28. 'Sins of Emission', op. cit.
29. *Sunday Telegraph Magazine*, 20.9.87.
30. *Guardian*, 9.2.89.
31. *Observer*, 6.12.87.
32. 'Sins of Emission', op. cit.
33. *Observer*, 6.12.87.
34. National Pure Water Association, newsletter, October 1988.
35. *London Evening Standard*, 3.11.86.
36. *Caring for Water & the Environment*, Water Authorities Association booklet, July 1987.
37. *Sunday Times*, 12.3.89.
38. ibid.
39. *Sunday Times*, 26.2.89.
40. 'Sins of Emission', op. cit.
41. *Times*, 16.8.88.
42. *Sunday Times*, 13.11.88.
43. *Sunday Times*, 4.12.88.
44. 'Sins of Emission', op. cit.
45. ibid.
46. *Sunday Telegraph Magazine*, 20.9.87.

5. WATER AND SEWAGE TREATMENT

1. *Farming News*, 9.12.88.
2. *River Dee Abstraction Scheme*, Grampian Regional Council booklet.
3. *Persley Sewage Treatment Works*, Grampian Regional Council pamphlet.
4. *Aberdeen Long Sea Outfall*, Grampian Regional Council booklet.
5. *The North Sea*, BBC2 Scotland, op. cit.

6. *Aberdeen Long Sea Outfall*, op. cit.
7. Quoted in 'Sea of Troubles', Pat Sinclair, *Radio Times*, 31.12.88.

6. WHAT'S NATURALLY FOUND IN WATER

Material found in this chapter is drawn mostly from US Environmental Protection agency documents, the American Journal of Public Health, and other xeroxed but unreferenced off-prints.

7. TREATMENT — OR TOXIN?

1. 'Sins of Emission', op. cit.
2. 'Learn to Live Without Chlorine'. Anthony DeCrosta, *Organic Gardening*, December 1978.
3. ibid.
4. 'What's the Harm in Aluminium', Ann Prescott, *New Scientist*, 21.1.89.
5. 'Aluminium in Water Puts Kidney Patients At Risk', Phyllida Brown, *New Scientist*, 21.1.89.
6. *Sunday Telegraph Magazine*, 20.9.87.
7. *Times*, 21.7.88.
8. *Sunday Telegraph Magazine*, 20.9.87.
9. *Times*, 14.7.88.
10. *Mail on Sunday*, 19.6.88.
11. 'Aluminium In Water Puts Kidney Patients At Risk', op. cit.
12. *Times*, 14.7.88.
13. 'Aluminium in Water Puts Kidney Patients At Risk', op. cit.
14. *Guardian*, 13.6.88.
15. *Mail on Sunday*, 17.7.88.
16. *Guardian*, 13.6.88.
18. *Observer*, 2.10.88.
19. *Times*, 22.8.88.
20. *Observer*, 21.8.88.
21. *Observer*, 2.10.88.
22. *Times*, 5.9.88.
23. *Sunday Times*, 4.12.88.
24. *Observer*, 21.9.88.
25. *Sunday Times*, 27.11.88.
26. *Observer*, 4.12.88.

27. Letter from Director of Water Services, Gampian Regional Council.
28. Letter from Director of Technical Services, Southern Water Authority.
29. *Hansard*, 6.3.80, Column 772.
30. *Fluoride and Truth Decay*, Scottish Green Party pamphlet, reprint July 1988.
31. National Pure Water Association, newsletters, October 1988 and January 1989.
32. *Hansard*, 5.3.85, Column 936.
33. *Hansard*, 12.6.78, Column 771.
34. National Pure Water Association pamphlet, quoting *The Lancet* 1973, ii, 877.
35. ibid. quoting *The Lancet* 1972, i, 1135.
36. 'Report on Fluoridation of the Royal College of Physicians (England)', an appraisal by the Lord Douglas of Barlock KCMG, NPWA pamphlet (Rapaport, I., various studies).
37. *Fluoride and Truth decay*, op. cit.
38. ibid.
39. 'Fluoride: The Poison in our Midst', Doris Grant, *The Ecologist*, Vol. 16, No. 6, 1986.
40. ibid.
41. Representation on Fluoridation, NPWA pamphlet, p. 4.
42. The Primary Question of Principle, NWPA pamphlet, 1963, 1982.
43. 'Fluoride: The Poison in our Midst', op. cit.
44. *Agriculture Handbook No. 380.* Agricultural Research Service of the US Department of Agriculture, August 1970.

8. LEAD PIPES AND LAND USE

1. Letter from A.R. Aldous, Director, Aldous & Stamp Ltd.
2. 'Sins of Emission', op. cit.
3. Channel 4 documentary on lead, 30.10.88.
4. *Surveyor*, 14.4.88.
5. Letter from Director of Water Services, Grampian Regional Council.
6. Letter from Director, Water & Drainage, Central Regional Council.
7. *Scotsman*, 31.10.88.
8. *Observer*, 19.3.89.
9. 'Sins of Emission', op. cit.

10. *Daily Telegraph*, 6.7.88.
11. 'Muck Spreaders', *Sunday Times*, 5.3.89.
12. ibid.
13. *Times*, 22.9.88.
14. *Sunday Telegraph*, 7.9.86.
15. *Farming News*, 9.12.88.
16. *Farming News*, 30.9.88.
17. *Farming News*, 21.10.88.
18. *Sunday Telegraph Magazine*, 20.9.87.
19. *Nitrates: A Needless Danger*, op. cit.
20. ibid.
21. ibid.
22. *Guardian*, 9.10.86.
23. *Daily Telegraph*, 2.5.88.
24. *Financial Times*, 14.3.88.
25. *An Investigation of Pesticide Pollution in Drinking Water in England and Wales; A Friends of the Earth Report on Breaches of the EEC Drinking Water Directive*, Andrew Lees & Karen McVeigh, for the Water Pollution and Toxics Campaign, 1988. pp.i-ii.
26. *Farming News*, 25.11.88.
27. *An Investigation of Pesticide Pollution . . .*, op. cit., p. 28, MAFF 1987, 'Effects of Pesticides on Human Health', Vol. II, House of Commons Agricultural Committee, Second Special Report, Session 1986-87, HMSO, para 743, p. 387.
28. *An Investigation of Pesticide Pollution . . .*, op. cit., p. 30, 'Water Pollution by Fertilisers and Pesticides', OECD Paris 1986.
29. *An Investigation of Pesticide Pollution . . .*, op. cit., p. 45, International Group of National Associations of Manufacturers of Agrochemical Products (1987) 'GIFAP Strategy to achieve rational and acceptable EEC legislation for pesticides in drinking water', GIFAP No. C87/DG/390.
30. *An Investigation of Pesticide Pollution . . .*, op. cit., p. 45, from Croll, B.T. (1988) 'The effects of agricultural use of herbicides on fresh waters' in *Effects of Land Use on Fresh Waters*, ed. J.F. de L.G. Sole, Water Research Centre.
31. *An Investigation of Pesticide Pollution . . .*, op. cit., p. 30.
32. *Memorandum and evidence submitted by the Royal Society of the Protection of Birds to House of Commons Environment Committee*, Third Report on the Pollution of Rivers and Estuaries, HMSO 1988, p. 283.

33. *Sunday Times*, 19.3.89.
34. *An Investigation of Pesticide Pollution . . .*, op. cit. p. vi, Environmental Data Services, 151, August 1987.

9. INDUSTRIAL DISASTERS

1. *ACOPS Yearbook 1986-87*, Advisory Committee on Pollution of the Sea, p. 8.
2. ibid., p. 9.
3. *Sunday Times*, 27.11.88.
4. *Independent*, 17.3.89.
5. *ACOPS Yearbook 1986-87*, p. 11.
6. *Observer Scotland*, 15.1.89.
7. *ACOPS Yearbook 1986-87*, p. 9.
8. *Observer Scotland*, 15.1.89.
9. *Observer*, 8.2.87.
10. *Guardian*, 10.3.89.
11. 'Britain's Dirty Business', Geoffrey Lean & Eileen Macdonald, *Observer*, 4.9.88.
12. 'Whatever Became of the Karin B', *Earth Matters No. 2*, Friends of the Earth.
13. *Guardian*, 10.3.89.
14. 'Britain's Dirty Business', op. cit.
15. *Guardian*, 10.3.89.
16. *Sunday Times Scotland*, 10.3.89.
17. *Sins of Emission*, op. cit.
18. *Observer*, 9.2.89.
19. *Times*, 2.3.89.
20. *Sunday Times*, 19.3.89.
21. *Aberdeen Press & Journal*, 16.3.89, also transcript of EAA President's speech.
22. *Sunday Times*, 13.11.88.
23. 'The Water Rats', Insight investigation, *Sunday Times*, 26.2.89.
24. *Sunday Times*, 13.11.88.
25. 'The Water Rats', op. cit.
26. *Guardian*, 1.3.89.
27. 'The Water Rats', op. cit.
28. ibid.
29. *The North Sea*, BBC2 Scotland, 12.1.89.
30. *Sunday Times*, 13.11.88.
31. 'Sea of Troubles', Pat Sinclair, *Radio Times*, 31.12.88.
32. *Sunday Times*, 4.12.88.

10. THE NORTH SEA

1. *The North Sea*, Friends of the Earth (Scotland), broadsheet.
2. *ACOPS Yearbook 1986–87*, Advisory Committee on Pollution of the Sea, London 1987, p. 12.
3. Letter from Maarten van der Kolk, *Sunday Times*, 5 March 1989.
4. *Observer*, 20.4.86.
5. *The North Sea*, BBC2 Scotland, 12.1.89.
6. *ACOPS Yearbook*, op. cit., p. 4.
7. *Observer*, 30.10.88.
8. *The North Sea*, BBC2 Scotland, 5.1.89. Greenpeace address to the Second International Conference on the Protection of the North Sea.
9. *Observer*, 1.1.89.
10. *Observer Scotland*, 30.10.88.
11. *ACOPS Yearbook* op. cit., p. 12.
12. *The North Sea*, BBC2 Scotland, 5.1.89, op cit.
13. *ACOPS Yearbook* op. cit., p. 13.
14. *The North Sea*, FoE (Scotland), op. cit.
15. ibid.
16. *The North Sea*, BBC2 Scotland, 12.1.89, op. cit.
17. ibid.
18. *The North Sea*, BBC2 Scotland, 5.1.89, op. cit.

11. ACID RAIN

1. *The Prophecies of the Brahan Seer*, Alexander Mackenzie, first edition 1877; revised edition 1977, Constable, ed. Elizabeth Sutherland, p. 49.
2. ibid., p. 49.
3. *Poems and Prophecies*, William Blake, Dent 1972, p. 110, 'Preface to Milton', line 8, 1803.
4. ibid., p. 97, 'The Book of Ahania'.
5. *Acid Rain*, Green Party briefing sheet.
6. *Atmosfear*, Friends of the Earth (Scotland) broadsheet, 1987.
7. *Acid Rain*, Fred Pearce, Penguin 1987, p. 22.
8. *Acid Rain*, Steve Elsworth, Pluto Press 1984, p. 53.
9. ibid., p. 52.
10. *Acid Rain*, Fred Pearce, op. cit., p. 37.
11. *Atmosfear*, op. cit.

12. ibid.
13. *Acid Rain*, Fred Pearce, op. cit., p. 100.
14. *Acid Rain*, Steve Elsworth, op. cit., p. 18.
15. *Acid Rain*, Fred Pearce, op. cit., p. 97.
16. *Daily Telegraph*, 9.10.88.
17. *Acid Rain*, Fred Pearce, op. cit., p. 107.
18. *Atmosfear*, op. cit.
19. *Acid Rain*, Green Party, op. cit.
20. *Atmosfear*, op. cit.
21. *Acid Rain*, Fred Pearce, op. cit., p. 79.
22. ibid., p. 75.
23. *Acidification of Lakes: Effects on Waterbirds in Sweden*, Mats O.G. Eriksson, Ambio Vol. 13, No. 4.
24. *Atmosfear*, op. cit.
25. *Atmosfear*, op. cit.
26. *Acid Rain*, Fred Pearce, op. cit., pp. 48-49.
27. ibid., p. 51.
28. *Atmosfear*, op. cit.
29. *Acid Rain*, Green Party ,op. cit.
30. *Acid Rain*, Fred Pearce, op. cit, p. 79.
31. ibid., p. 15.
32. *Acid Rain*, Steve Elsworth , op. cit., p. 60.
33. *Daily Telegraph*, 10.9.88.
34. *Atmosfear*, op. cit.
35. *Acid Rain*, Fred Pearce, op. cit., p. 140.
36. ibid., p. 137.
37. *Atmosfear*, op. cit.
38. *Acid Rain*, Fred Pearce, op. cit., p. 138.
39. ibid., p. 134.
40. *Acid Rain*, Steve Elsworth, op. cit., p. 61.
41. *Acid Rain*, Fred Pearce, op. cit., p. 134.
42. *Sunday Times*, 19.2.89.
43. *Sunday Times*, 5.3.89, letter from Professor D. Cole-Hamilton.
44. *Acid Rain*, Fred Pearce, op. cit., p. 139.
45. 'Fluoride: "The Smoking Gun' in Acid Rain", Gladys Caldwell, *The American Sunbeam*, November 1982, quoting U.S. Dept. of Agriculture Handbook #380.
46. *Sunday Times*, 19.2.89.
47. 'Flouride: "The Smoking Gun" in Acid Rain', op. cit.
48. ibid.
49. ibid.

50. ibid., quoting Marler & Rose, Canadian Research Council.

12. PRIVATISATION

1. 'How Green is the Prime Minister?' Geoffrey Lean, *Observer*, 5.3.89.
2. *Times*, 2.3.89.
3. *Liquid Assets*, op. cit., p. 10.
4. *Guardian*, 9.2.89.
5. *Sunday Telegraph Magazine*, 20.9.87.
6. *Times*, 16.6.88.
7. ibid.
8. *Guardian*, 9.2.89.
9. *Observer*, 21.9.88.
10. *Observer*, 1.1.89.
11. *Observer*, 26.2.89.
12. *Daily Telegraph*, 25.2.89.
13. *Guardian*, 9.2.89.
14. *Scotsman*, 28.2.89.
15. *Liquid Assets*, op. cit., p 15.
16. 'The Water Rats, Part III', op. cit.
17. *Liquid Assets*, op. cit., p. 11.
18. *Liquid Assets*, op. cit., p. 14.
19. 'Troubled Waters', Ian Williams, *Sunday Times*, 12.2.89.
20. 'A Sort of Watergate', George Pitcher, *Observer*, 12.2.89.
21. *Guardian*, 28.2.89.
22. *Liquid Assets*, op. cit., p. 19.
23. 'Land, Land Everywhere', Charles Clover, *Daily Telegraph Weekend Magazine*, 14.1.89.
24. *Liquid Assets*, op. cit., p. 19.
25. ibid., p. 22.
26. ibid., p. 22.
27. ibid., p. 22.
28. ibid., p. 18.
29. ibid., p. 25.
30. ibid., p. 23.
31. ibid., p. 23.
32. ibid., p. 23.
33. 'The Water Rats, Part III', op. cit.
34. op. cit. 3, pp. 26-27.
35. ibid., p. 27.
36. ibid., p. 27.

37. 'The Water Rats, Part III', op. cit.
38. ibid.
39. ibid.
40. *Liquid Assets*, op. cit., p. 37.
41. ibid., p. 37.
42. ibid., p. 37.
43. *Independent*, 17.3.89.
44. *Scotsman*, 18.3.89.
45. *Observer*, 19.3.89.
46. *Sunday Times*, 19.3.89.

POSTSCRIPT

1. *Observer*, 21.5.89.
2. ibid.
3. *Guardian*, 1.4.89.
4. *Times*, 20.4.89.
5. *Sunday Times*, 21.5.89.
6. *Observer*, 2.4.89.
7. *Scotsman*, 27.4.89.

APPENDIX A: AN ABC OF DOMESTIC WATER PURIFICATION

'What Price Pure Water?' Robin Murrell, *Environment Now*, No. 5, June 1988. This article examines the difficulties and dangers involved in selecting a reliable domestic purification system.

INDEX

OPTIMA

Water, water, everywhere,
But is it fit to drink?

DOWN THE DRAIN is a scathing indictment of how we abuse and misuse our most valuable natural resource. This broad and detailed investigation of both official sources and independent studies:

- **shows how acid rain, lead pipes, raw sewage and pesticides contaminate our water supply, destroy flora and fauna and endanger our health.**
- **identifies the natural properties of water, and explores the implications of modern water treatment processes like chlorination.**
- **traces the history of human reliance on water, from ancient water cults, through the Black Death, to the Victorian concern with public sanitation.**
- **questions the viability of the privatisation of the water authorities in England and Wales.**

Equally damning of domestic apathy, industrial negligence, and official cynicism, DOWN THE DRAIN urgently presses for new thinking and action to halt our quickening slide into environmental disaster.

MACDONALD OPTIMA

Category:
CURRENT AFFAIRS/
ENVIRONMENT

Cover design/photography by Jefferson Godwin

UK £5.99

ISBN 0-356-17944-3

00599

Australia $19.95*
New Zealand $21.95* (incl. GST)